METAL INDUSTRY

VOLUME 93 NUMBER 8 22 AUGUST 1958

Trade with the East

SOME interesting news was released last week regarding substantial changes in the scope of the control of exports by the United Kingdom to countries in Eastern Europe and China. The general effect of these changes is to broaden the existing wide field of goods which may be exported to these destinations without restriction. A revised embargo list has been issued and is now effective. This list applies to Albania, Bulgaria, China, Czechoslovakia, Hungary, North Korea, North Vietnam, Poland, Roumania, the Soviet Union, the Soviet Zone of Germany, and Tibet. The number of items which were formerly barred to these countries has been reduced from 181 to 118, this number including some goods which have been newly added. Twenty-five items which were subject to quantitative control have now been freed from all restrictions. Among the goods which can now be freely sold to Communist countries are civil aircraft and aero engines, some types of ships, oil well drilling equipment, petroleum refinery and petro-chemical plant, electric generators and motors, turbines, petroleum products, vehicles, industrial diamonds, and all forms of *aluminium and copper*.

It is certainly good news that the Western Powers have been able to agree on a substantial relaxation of the controls on exports to the Soviet bloc. It is a satisfactory outcome for the British Government, which has been pressing for some time for the embargo list to be confined to goods which are still of genuine strategic significance. The previous controls had been in force, with merely some minor adjustments, since 1954 and it was obvious that the various scientific and industrial advances on the Soviet side made some of these restrictions a matter of farce. In fact, it can be considered doubtful whether the embargo really curtailed trade to any great extent. Obviously, the Russians would have been glad to buy certain military and scientific equipment which had been denied them, but it would seem that there was little evidence that genuine trade has been frustrated by the controls.

It is perhaps true to say that the Russians are not so interested in buying from countries outside their own bloc as we think. The main object of the Russians is self-sufficiency, as we should well know by now, and any trade they may do with Western countries is largely marginal and chiefly for the purpose in the production plan. The record in recent years bears this out. An analysis in the last issue of the *Board of Trade Journal* shows the lack of any steady pattern in Russian purchases from this country, while it also shows that it has been declining sharply in the past year. However, it should not be thought that efforts to increase sales to the Soviet bloc are not worth while.

There should be some advantage to the United Kingdom in this. For instance, Russia has always wanted more copper than she was allowed to have, and the freeing of some scientific instruments, such as spectrographs, electron microscopes and diffraction equipment, is also likely to prove an attraction. An increase in the flow of West-East trade should prove of real economic advantage to all European countries. Those business organizations which have been saying for so long that they could sell much more to the Communist countries if the embargoes were removed will now have an opportunity to show what they can do. But it would be wise not to be too optimistic on this score.

Out of the
MELTING POT

Plugging WHERE, in the past, it has been difficult or impossible to produce certain alloys comprising constituents that did not like alloying by the usual melting procedures, use had to be made of the techniques of powder metallurgy which mixed the powdered constituents together and then made them stick and stay together by pressing and sintering. The news has now been published that in future it may often be possible to replace the slow persuasion of the powder metallurgical technique in bringing about the desired union, by the more rapid, and certainly more drastic, method of what might almost literally be described as a shot gun marriage technique. Called micrometeorite bombardment, the technique involves the use of a linear accelerator to speed up particles of up to 25 thousandths of an inch to speeds exceeding 50,000 m.p.h. Speeds even higher than that are considered to be possible. Particles of a chemically stable material travelling at this speed, when they strike a solid are "inserted" into the crystal lattice of the solid. In this way, new molecular arrangements may be formed to create new properties in a material or to combine desirable properties of several materials. For example, such disparate metals as aluminium (boiling point 3,740°F.) and iridium (melting point 4,450°F.) can be combined by the high speed bombardment technique which will insert solid iridium particles into the aluminium lattice to produce a metal with the characteristics of aluminium and increased high temperature properties. Another use of the technique is for studying how surface "skins" of missiles are affected by high speed particle bombardment simulating the meteoric particles they are likely to encounter in outer space.

The Lot SOME interest in the phenomenon of the dispersion hardening of metals by constituents insoluble in the particular metals and, as the term implies, dispersed in the form of very fine particles throughout the metal, was originally aroused by silver alloys in which the hardening constituent consisted of particles of the oxide of the alloying metal formed *in situ* by internal oxidation. Dispersion hardening was put firmly on the map of practical, as distinct from academic, metallurgy by the discovery of SAP—the aluminium-base material in which the dispersion hardening oxide constituent derives from the oxide films on the particles of the suitably chosen aluminium powder, and in which the dispersion of this oxide is effected by appropriate mechanical working operations to which the powder is subjected in the course of being transformed to the finished wrought material. The remarkable properties of SAP stimulated research into the possibilities of aluminium-base compositions dispersion hardened by constituents other than aluminium oxide, and the achievement of modest improvements in certain directions, e.g. in bearing properties, and certain high-temperature properties, has been claimed for additions of iron-silicon and some other hard insoluble intermetallic compounds. What looks like the outcome of a far more ambitious research project, however (or a plan of one) has now been revealed in a patent claiming a structural material capable of unusual strength and hardness up to about 1,200°F. This material consists of an intimate finely divided mixture consisting of 75 to 95 parts by weight of aluminium or aluminium alloy and 25 to 5 parts by weight of an oxide of magnesium, titanium, vanadium, chromium, zirconium, lanthanum, cerium, and praseodymium, mixtures of these oxides with aluminium alloy strengthening metals such as iron, molybdenum, vanadium, titanium, tantalum, columbium, chromium, manganese, nickel, tungsten, boron and the rare earth elements, mixtures of these oxides with aluminium oxide, and mixtures of these oxides with the above strengthening metals and aluminium oxide. Anything else?

Salvation READING the preamble to a patent specification reviewing the state of the prior art in some particular field, one is usually led to wonder how in fact this prior art had managed to struggle along and achieve any sort of results before the new invention providentially turned up to improve matters. Thus, for example, quite a number of drawbacks would appear to have been the lot of the various hard solders used hitherto for joining such recalcitrant materials as chrome-nickel steels, tool steel, and heat-resisting alloys. Either the compositions of these solders were such that the working temperatures were too high, resulting in annealing, grain growth and scaling of the work, or if the compositions were altered to lower the working temperatures, then the heat-resistance and durability were impaired. The compositional complexity arrived at as a result of attempts to overcome these drawbacks was increased by further additions intended to improve the flow behaviour and wetting power of these solders. The above apparently deplorable prior art should now undergo a substantial improvement following the surprising discovery that alloys of the ternary system cobalt-copper-manganese with 1-10 per cent cobalt, 55-95 per cent copper and 4-35 per cent manganese, are very suitable as solders for alloy steels, hard metals and other materials which are difficult to solder. Alloys in the range of 2·5-6 per cent cobalt, 80-90 per cent copper and 7·5-15 per cent manganese have proved especially satisfactory. The working temperatures of these alloys are between 1050 and 900°C. The melting range is narrow, so that the alloys show no tendency to form shrinkage cavities when they are used as solders. They have good flow and wetting characteristics. On the mechanical side, the cobalt-copper-manganese hard solders combine excellent toughness with an adequate degree of hardness, and in addition they have an excellent heat-resistance. Furthermore, their mechanical properties can be increased by heat-treatment. From the manufacturing point of view, it is pleasant to learn that they can be rolled and drawn satisfactorily in the cold. Finally, to counteract any feeling that these new solder compositions are too simple to be good, it ought to be added that they may, should this be required, also contain chromium, nickel, iron, silicon, palladium, silver, gold, titanium and vanadium, provided such additions together do not exceed the cobalt content of 5 per cent.

Skimmer

GRAVITY DIE-CASTING — PRESSURE DIE-CASTING

Some Aspects of Modern Aluminium Casting

By L. FLETCHER

(*Concluded from* METAL INDUSTRY, 15 *August* 1958)

ONE of the great virtues of aluminium as a foundry material lies in the fact that it can be cast in sand moulds or in metal moulds (or dies); in the latter case, the metal may be simply poured into the mould, when the process is known as gravity die or permanent mould casting, or it may be forced in under pressure, as in the pressure die-casting process.

From the figures already given, it will be noticed that gravity die-casting is the most important process used in the U.K., and accounts for over half the total quantity of aluminium castings produced.

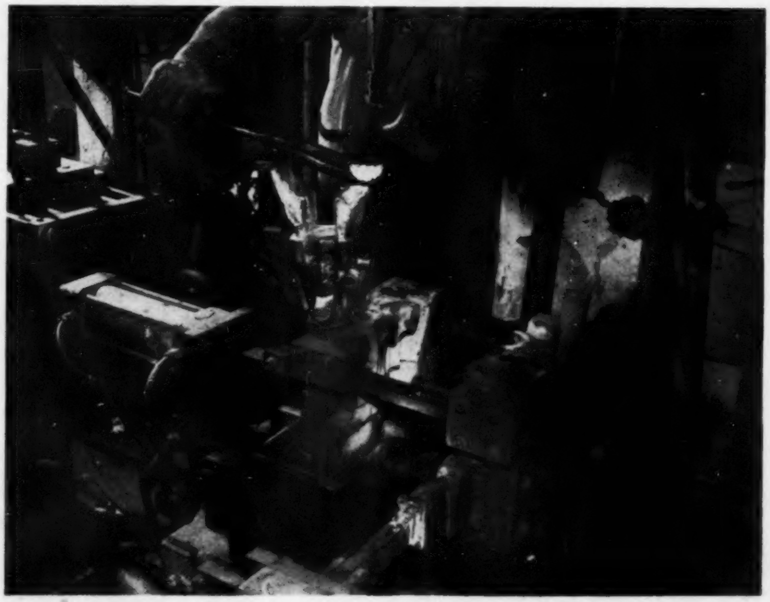
Castings produced in permanent moulds have a finer grain structure than sand castings because of the chilling effect of the metal dies, and better mechanical properties. They also have a smoother surface and a closer dimensional accuracy; the soundness of the metal is improved, too. Gravity die-casting, therefore, gives a product of superior quality, and is preferred where production is on a sufficient scale to justify the expense of the dies. Once these have been purchased, the cost of a gravity die-casting is usually less than that of the equivalent sand casting, because of the higher production rates obtainable and less skill required. In addition, the weight of the casting and the amount of machining which must be performed may sometimes be reduced.

The simplest type of die is a book mould in which the die halves are hinged at one edge and provided with a locking mechanism at the opposite edge. A common alternative arrangement is to make the moving die half slide towards or away from the fixed die block. The die cavity is provided with the usual runners, risers, gates and vents, and provision is made for manual or mechanical opening and closing of the die and ejection of the finished casting. The internal die surfaces are sprayed with a mould wash to protect them from the action of the molten metal. With castings of complex shape, cores may be necessary, and these may consist of fixed, sliding or collapsible metal cores, loose pieces or sand cores. The latter are used if the core is an awkward shape and where it is required to collapse under the contraction of the solidifying metal.

Where the design of the casting is suitable, the various movements of the dies and cores can often be performed by hydraulic or pneumatic rams. The use of power-actuated dies is one of the most important developments in modern gravity die-casting practice. It enables output to be increased and reduces human fatigue, and also makes possible the application of automatic control. A single operator is often able to manage two machines, by attending to one die whilst the casting in the other is solidifying. If necessary, air or water cooling of the dies can also be employed to hasten solidification. Under favourable conditions, the output of a mechanized gravity

General purpose gravity die-casting machine. Die closed, pouring in progress

General purpose gravity die-casting machine. Die opened, casting extracted



Gravity die-casting machine for producing sink units. Pouring in progress

die-casting unit may approach that of a pressure die-casting machine. Logically, the next step will probably be the introduction of automatic metal transfer from the holding furnace to the die, as with the Ajaxomatic unit.

Small components can often be produced most efficiently in general purpose machines. These comprise a bench upon which air-actuated rams are mounted to give the necessary motions to the moving cores and dies. One operator attends to two machines. Metal is ladled into one die, and whilst the casting is solidifying the other die is opened, the casting removed, and the die closed, ready for pouring again. A typical general-purpose machine of this type, producing hydraulic brake cylinders with steel bolt inserts, has an output of 100 parts/hr. for each operator, or 50 per die.

In another type of machine, built to produce gearbox extension pieces, an improvement in output of 40 per cent compared with manual operation has been obtained by power actuation of the dies and core slides. A main sand core is used, built up from core pieces cured by the carbon dioxide process; also auxiliary metal cores, moved by die-actuated wedges or a hydraulic ram. Both die halves are made to close and open hydraulically. Between the die halves slides a double core frame. The casting is removed from one side of this frame and a new core put in place, whilst the metal in the other section is solidifying. The die is then opened, the core frame is moved along, the die halves close, the metal is poured, and the cycle is repeated. This type of machine is very useful where sand cores must be used, because loading and unloading are simplified.

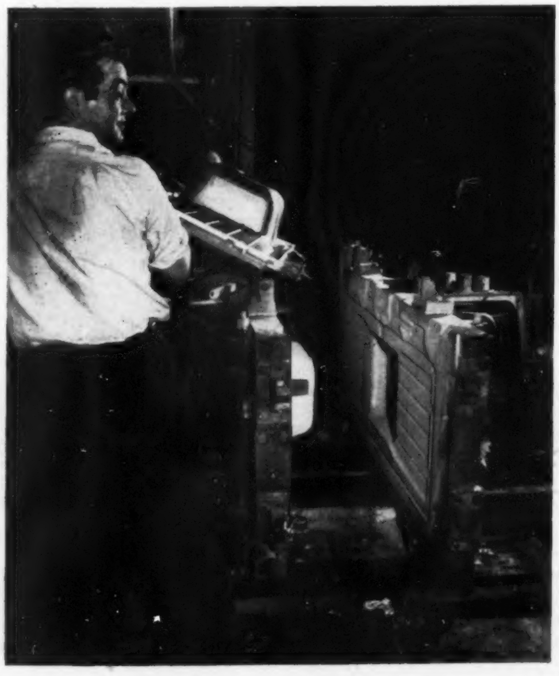
A good example of a large and fairly intricate gravity die-casting is the domestic sink unit cast in LM6M alloy. The casting is 63 in. long and 21 in. wide, the thickness being nowhere greater than $\frac{3}{16}$ in. The net weight is 36 lb. The mould is in two halves, one fixed and the other moved on slides by a pneumatic ram. The casting is poured from both ends and is air-cooled at the main runner end. Hand locking and ejection are used. Another, simpler, example of successful gravity die-casting consists of the end bearer for lorry bodies. These components were formerly made of timber, but there are economic and technical advantages in producing them as aluminium castings. The two-part die used is manually operated. The castings are complete with bolt holes and require no machining: they are simply assembled to the body and chassis.

Pressure Die-Casting

Where the output of any one casting warrants the installation and operation of the expensive equipment, pressure die-casting is generally the preferred method of making cast aluminium products. In finish, reproduction of detail, maintenance of tolerances and rate of production, pressure die-castings are superior to those produced in gravity dies and, of course, superior to sand castings. Apart from a tendency for occasional defects due to oxides or entrapped air to develop in the casting, the mechanical properties are good, whilst little machining is generally necessary.

Pressure die-castings are made by forcing molten metal into steel dies. The machines used differ only in the means of injecting metal into the die. In the case of aluminium, the cold chamber type of machine is preferred, to avoid continuous contact between the operating parts and the molten aluminium. The metal is transferred from the holding pot to a chamber in the die-casting machine, and forced by the action of a plunger into the die, where the metal rapidly solidifies. The die then opens and the casting is ejected.

As in gravity die-casting, cores can be provided where necessary. The chief problem is in providing a means of allowing the air in the die cavity to escape during the very rapid injection of the metal. The pressure required to inject the metal and to operate the slides for the die mechanism is usually provided by hydraulic means; die locking pressures of up to 2,000 tons are used in large machines.



Gravity die-casting machine for producing sink units. Die opened and casting removed

Manually operated die for lorry body rear bearer casting, showing moving die half

Manually operated die for lorry body rear bearer casting, showing stationary die half, with ejector pins and plate advanced to eject casting

A typical cold chamber die-casting machine suitable for aluminium is hydraulically operated and self-contained, the pumps and accumulator being built into the machine. Manual and semi-automatic operation, with push-button control, are provided. Ejection of the casting is automatic, by rods which pass through holes in the moving die plate, and hydraulic core-pulling equipment can be mounted on the fixed or moving dieplates.

The dies are locked hydraulically by a toggle to give a locking pressure of 250 tons, and the hydraulic injection plunger is interlocked with the die closing. The metal is ladled into a Nitralloy pouring sleeve and transferred to the die by a hydraulic plunger. After a cooling period, the dies are opened by push-button control, or by a timer variable between 6 sec. and 90 sec. The size of plunger can be altered to produce a weight of aluminium per shot between 1·25 and 3·5 lb., with a casting area between 28 in^2 and 79 in^2.

Although the size of component which can be made by pressure die-casting is naturally limited by the size of the casting machine, quite large castings have been made in this way, including a six-cylinder automobile engine block weighing 70 lb. In the U.S.A., the major tonnage of aluminium castings is produced by the pressure die-casting process, much of this being in the form of automobile components such as gear boxes, clutch housings, sumps, pistons, and so on. The use of this method is also growing in the U.K., and recent examples of pressure die-cast components include a casing for a radio-activity monitoring unit and a cover for a bill-issuing device, both of which were produced in LM6 alloy on a machine of 600 tons capacity.

Plating Control

VARIATIONS in mains voltage and frequency are potential sources of trouble in electroplating processes, and the Davenset automatic constant voltage controller has been introduced to overcome these variations. With this instrument, the plating voltage can be preset to a required value and will thereafter remain constant irrespective of variations in the plating current from zero to full load, thus burning and uneven plating are avoided.

A constant voltage is maintained irrespective of quite wide variations of voltage and frequency in the mains supply.

The constant voltage control cubicle can be situated remotely from the plating rectifier and plating bath, if necessary under lock and key. This ensures that once the voltage for a particular plating run has been set, interference by unauthorized persons is impossible.

The voltage can be preset at any value between 8 and 16 V, and will remain constant irrespective of variation in plating current from zero to 250 amp.

The Davenset automatic constant voltage controller is also available for use with existing plating rectifier installations. This equipment is a product of Partridge Wilson and Co. Limited, Davenset Electrical Works, Evington Valley Works, Leicester.

Titanium Production

A REVIEW of the work carried out to date on "The Chemistry and Metallurgy of Titanium Production" has been published under this title by the Royal Institute of Chemistry. It briefly describes the discovery of the metal and the subsequent search for a means of producing a workable material. The ores are dealt with, and the intermediate materials are described. The section dealing with the reduction stage outlines the Kroll process and the sodium reduction process, and the section which follows deals with the isolation of the titanium metal from the sponge by vacuum distillation and leaching. The remaining sections deal with specification and analysis, research on new extraction processes, melting practice, processing of titanium ingots, and physical and mechanical properties.

This monograph is obtainable from the Institute at 30 Russell Square, London, W.C.1, price 7s. 0d.

REPORT OF CONFERENCE AT THE UNIVERSITY OF BIRMINGHAM

Pressure Welding

IN pursuance of a policy of furthering teaching and research in the field of metal joining, the Department of Industrial Metallurgy at the University of Birmingham organized, on June 19, a conference on the pressure welding of metals. Professor E. C. Rollason, head of the Department of Industrial Metallurgy, was in the chair, and ninety representatives from industry, the research associations and the universities attended. After explaining the purpose of these conferences, Professor Rollason reviewed the origins and development of the practice of pressure welding, and the progress that had been made towards establishing a theoretical model. Three Papers were then presented, the first, by J. A. Donelan, of the Research Laboratories of The General Electric Company, dealt with industrial practice, the second, by L. R. Vaidyanath, M. G. Nicholas and D. R. Milner, gave an account of the researches being carried out at the University of Birmingham, and the third Paper, by Dr. E. Holmes, of the University of Nottingham, was concerned with the relative importance (upon bond formation) of movement at the interface, oxide break-up, and the deformation of surface asperities.

Development

The idea of joining metals by pressure is not new, as it has been employed in the hammer forged blacksmith's weld from the earliest days of the use of iron. However, this may be a special case as it depends on the squeezing out of a layer of molten slag from beneath the two components to be joined. The general practice of joining metals by the application of pressure and without melting was first established in the U.S.A. in 1887, when Professor Elihu Thomson invented resistance welding. It would appear that the metallurgical distinction between flash welding, involving liquid phase joining, and resistance butt welding in the solid phase was not then realized, but it is clear from the examples of applications illustrated that a good proportion of solid phase welds were made, with resistance heating used to aid the deformation. With the development of high-temperature blowpipes, pressure welds were made with the necessary localized heating provided by gas burners, and it was found that at high temperatures it was possible to join most metals and alloys. Then, in 1946, The General Electric Company showed that, by using careful surface preparation techniques and controlled deformation, a large number of metals could be welded at room temperature. While the commercial application and scope of cold welding were not realized until relatively recently, the principle had, in fact, been demonstrated before the Royal Society as far back as 1724 by the Rev. J. T. Desaguliers. This remarkable cleric took two spheres of lead, cut a small flat on each with a penknife, and pressed the two together by hand, at the same time giving them a slight twist. The joint strengths obtained, as measured by a steelyard, were remarkably strong, in some cases the strength approaching that of solid lead.

To-day, it is generally accepted that the majority of metals can be pressure welded, if not at room temperature then at higher temperatures. There are four main techniques of application. First, there is a "stitch welding" type of process somewhat similar to spot welding; the two pieces of metal to be joined are overlapped and a number of small welds made by indenting with suitable punches; by making a continuous indentation with rollers a "seam" weld can also be formed. Secondly, there is the butt welding process, in which rod, tube, bar, or even strip 7-8 in. wide, is forged together, the deformation being limited to the interface by suitable guides. Thirdly, there is the familiar process of roll bonding, by which clad metals are produced. Finally, there are methods of producing welds by extruding the components together.

Advantages and Applications

The advantages of the pressure welding process lie in the metallurgical quality of the joint produced, the methods of application, and the fact that it can be used as a cold welding process. The metallurgical quality of the joint is good because a worked structure is obtained as opposed to the cast structure produced with the more conventional welding processes. The importance of this factor varies from one metal to another; with mild steel, for example, where arc welding electrodes have been developed to a high degree of perfection, and the metal undergoes a phase transition which refines the coarse cast structure, there is little advantage. But at the other end of the scale, to take extreme cases which are now finding some application in atomic energy and other fields of modern technology, there are beryllium and molybdenum, which are extremely brittle in the cast state so that a solid state welding process is essential. There are also some advantages to be gained with the heat-treatable aluminium alloys, where the hardenable structure may be preserved, and the low alloy steels, where the problem of cracking may be alleviated.

The advantages of the techniques of application depend to a large extent on the ingenuity of the designer. It is often the practice in the fabrication field to think from the start in terms of the finished article which is designed as a number of parts to be joined together, the means of joining only being considered at the last stage. This often leads to difficulty with the joining process, and for pressure welding would be a useless approach as the metal has to be deformed and account must, therefore, be taken of the consequent changes in shape at the beginning of the design stage. In some cases it may be possible to forge and join the article at the same time; an example of this was given by Donelan, who showed how small nuggets of silver could be forged into contacts and pressure welded to a copper backing bar in one operation. It is often found that the required properties can best be obtained by a combination of two or more metals, as, for example, in the combination of strength and corrosion resistance which results from cladding a heat-treatable light alloy with a thin layer of super purity aluminium, or for economic reasons, as with the cladding of mild steel with stainless steel. The cladding process has also been used for the production of brazing sheet; thus, if it is desired to make a large number of brazed joints to one sheet, as in the manufacture of a heat exchanger, instead of making innumerable additions of filler metal, a sheet of base metal is clad with a thin layer of the filler metal, which on heating melts and flows into the joints.

The most elegant example of the application of roll bonding is, however, the fabrication of refrigerator coolant panels. Two sheets of metal, aluminium, say, are prepared for bonding by scratch brushing, and an inhibitor is used to paint on the surface of one sheet a pattern of the liquid flow passages, which may be as complex as is desired. The two sheets are then rolled together so that they bond except where the pattern was printed; the liquid flow passages are then formed by inflating the unwelded regions. In these cases, the designer has been able to take into account the large amount of deformation which may be necessary. However, it is not true to assume that a large deformation is required under all conditions. If it is possible to weld at high temperatures (relative to the melting point of the metal) then there is an increasing amount of evidence to show that deformations of only 10-20 per cent will

give very good bond strengths. Also, if the metal oxide can be reduced and the weld made in an atmosphere of hydrogen, then, again, the deformation may be much reduced.

When applied at room temperature, large amounts of deformation of the order of 60 per cent reduction in thickness are required to get good bond strengths. But, nevertheless, it is the only metallic jointing process that can be applied cold and result in strong vacuum-tight joints. For this reason it is a particularly suitable technique for the canning of delicate components such as detonators or transistors. Often the degree of reduction can be designed for, and Donelan presented an impressive list of examples of the successful application of cold welding (using mainly aluminium or copper) which included, in addition to those mentioned already, the fabrication of electric kettles, the sheathing of polythene covered wires in aluminium by bending strip around the wires and making a continuous indent weld, the butt welding of wire, rod and bar (including welding aluminium rod to copper rod), and the welding of wires to connecting tags. Donelan stressed that for successful welding the most important factors are the surface preparation of the material (a degreasing treatment followed by scratch brushing being preferred), and the shape of the deforming tool.

Theory

The practice of pressure welding has been developed empirically and, as a result, it is now well established that a number of factors, e.g. surface preparation, temperature and tool shape, are important. However, despite a number of researches on the subject, no satisfactory theory has yet been developed. When pressure welds could only be made at high temperatures, it was considered that diffusion at the interface was essential to bring the surfaces into atomic contact, and for this reason, that welding was enhanced at the recrystallization and transition temperatures at which the rate of diffusion was considerably increased. With the advent of cold pressure welding, emphasis was shifted from the influence of the temperature of welding to the pressure applied, which then came to be regarded by some workers as the controlling factor.

These hypotheses, however, take little account of the practical necessity for careful surface preparation prior to welding, and more recent theories have concentrated on this aspect, in one case the penetration and fragmentation of the oxide film being regarded as critical, whereas in another case the difficulty of bringing roughened surfaces into intimate contact has been stressed. An alternative hypothesis has been advanced which implicitly assumes that the formation of bonds presents no difficulty but that, on release of the applied load, these bonds are at least partially broken apart by elastic recovery forces which vary from one metal to another. Finally, there is the possibility of relative movement between the joining surfaces, which, as workers in the field of friction have shown, leads to the formation of welds that are responsible for frictional restraint.

The difficulties in making an analysis of the formation of pressure welds are: first, the large number of parameters involved, and secondly, the fact that no satisfactory method has been developed for the measurement of the degree of bonding or bond strength which is obtained. A number of tests are in use, but these relate the bond strength to the processes through which the metal has to pass after welding and, while satisfactory in practice, the results do not lend themselves to analysis of the fundamentals of bonding. Part of the theme of the work of Vaidyanath, Nicholas and Milner was that the mechanism of pressure welding is best investigated via the roll bonding process since, for practical purposes, the reduction is uniform throughout the composite, and it is possible to measure the bond strength by a test giving results which are more amenable to analysis than those available hitherto. This work has led to the development of a theoretical model for the maximum obtainable joint strength from the concept that oxide films are completely brittle, so that when the interface is extended, areas of virgin metal are exposed, and these are the source of potential bonding. This model, however, is only generally applicable to cold welding, as at higher temperatures it is possible for the oxide film to diffuse into the adjacent metal: with Armco iron, for example, at about 800°C., the oxide diffuses to such an extent that the interface becomes obliterated by recrystallization and grain growth. The problem still remains of why the virgin metal areas which are created do not always join. From evidence on the effect of pressure, time, temperature and exposure of the surfaces to the atmosphere prior to rolling, the authors concluded that a correct theory must involve considerations of atomic movements during the deformation, diffusion, and the solution of entrapped gases. From the point of view of roll bonding practice, this means that welding is promoted by the use of large diameter rolls and low rolling speeds, but inhibited by absorbed moisture.

When dissimilar metals are welded, further problems arise in that if the two metals possess different mechanical properties they will not deform in the same manner; this can, to a large extent, be overcome by designing the deforming tools so as to introduce more restraint of the metal flow of the lower yield point metal. In addition, alloy layers will develop at the interface and may have a marked effect on the strength of the weld: if appreciable thicknesses of intermetallic layers are formed the weld will be very brittle, and if the weld is made at a high temperature between two metals having very different coefficients of expansion, the intermetallic layers may not even withstand the stresses imposed during cooling, so that the composite will fracture before it cools to room temperature.

Dr. Holmes showed that when dissimilar metals are bonded by rolling there will also be relative movement between the two surfaces as they enter the roll gap. He had investigated the effect of relative movement by controlled tests in small tool welding, and the results showed that substantial bonding could be obtained with relatively little deformation, the bond strength increasing with the amount of relative movement and with the applied load under which the movement was carried out. From further experiments designed to examine the relative importance of the difficulty of bringing rough surfaces into intimate contact and that of penetrating the oxide film, Dr. Holmes reached the conclusion that for conditions under which the flow of metal was restrained, oxide break-up was difficult to obtain, whereas, since restraint of necessity involves higher pressures, the deformation of asperities was readily achieved. Conversely, for conditions of low restraint, metal flow and oxide break-up took place readily, and the deformation of the surface asperities became the controlling process.

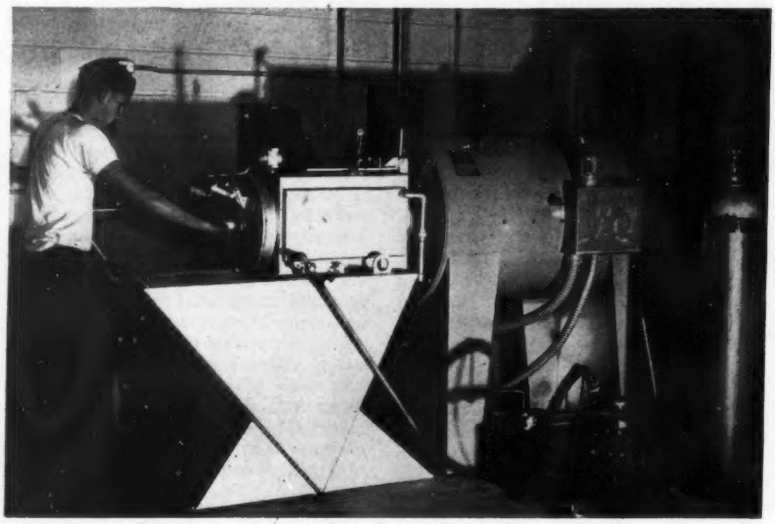
Discussion

It was clear from the discussion which took place after the Papers had been presented that pressure welding is contributing to the solution of some of the problems arising from modern technical developments. One interesting example was that cold pressure welding had been used to join the transatlantic cable; another example, again of the use of cold welding, rather colder than usual, in fact, was the fabrication of complex patterns of frozen mercury used as a variant of the lost wax process for precision casting. Mercury is particularly good for this purpose, as it welds very readily, giving strengths adequate for patternmaking by doing little more than just pushing two pieces together. The disadvantage of the relatively high deformation required for the welding of the more conventional materials at room temperature, limits the application of cold welding, and several possibilities which might lead to a reduction of this deformation were discussed. Recently workers in the U.S.A. have shown that the application of ultrasonic vibrations during the welding process resulted in bonds with very low deformations; originally the work had been limited to the joining of foil, but, with developments in transducers, up to 0·080 in. thick aluminium had been welded. Experience in this country has shown that the process has possibilities, but that much development work remains

to be done. The application of ultrasonic vibration involves complex and expensive equipment, and several workers are investigating the possibility of producing welds at low deformations by mechanically-caused vibrations between the surfaces at subsonic frequencies: again welds have been produced, but so far the strengths attained were not adequate. The use of impact loading was also discussed, but the results are inconclusive: some indicated little difference, while others suggested considerable improvements on those obtained by deforming at conventional speeds.

The divergence of the opinions expressed on the theory of pressure welding showed that very little progress had been made toward the development of a universally acceptable model, and the ultimate answer will probably show that the controlling parameter varies with the conditions of welding. The technique of surface preparation prior to welding received considerable discussion, and while many treatments have been tried, it is found that the best results, and for cold welding often the only results, are achieved with scratch-brushed surfaces. That no satisfactory reason could be offered for the success of this practice demonstrated again the inadequacy of the present state of the theoretical treatment of the subject.

Bright Heat-Treatment for Titanium



Vacuum and controlled atmosphere quench furnace for bright heat-treatment of titanium parts

SMALL titanium parts are now being heat-treated in a vacuum furnace with which is associated a purge chamber and quench tank that enables the heat-treatment process to be carried through with no diminution of brightness on the surface of the parts. The process is being operated at Metallurgical Consultants Inc., Maywood, California, and the furnace was developed by Pacific Scientific Co., Bell Gardens, California. It is probably the first unit of its type that is economically feasible for the average commercial heat-treater. In addition to titanium alloys, it can be used to process stainless steels and other metals requiring complete atmospheric protection during heat-treatment.

The main compartment of the furnace is a cylindrical heating chamber, in which Nichrome electrical elements are evenly spaced around the circumference of an Inconel retort. Adjacent to the heating unit is a purge chamber, positioned over a quench tank.

An internal shaft, which is externally controlled by a furnace operator, permits removal of a work basket from the retort to the purge chamber, where the basket is rotated—allowing heated parts to be individually and uniformly quenched in a cascading action.

High vacuum equipment is used to evacuate air from the furnace's retort and purge chamber, and a back purge of inert gas protects parts as they are heated. The location of the gas inlet is such that argon or helium must pass through the furnace's work load before entering the purge chamber and exhausting out of an open side of the quench tank.

Special radiation shields on the work basket concentrate the furnace's heat so that temperatures within the purge chamber and quench tank remain relatively low throughout the heating cycle, during which retort temperatures may be as high as 2,000° ± 5°F. (1,093°C.).

Magnesium Alloys

NEW magnesium-base alloys containing silver, rare earth metals and zirconium, designated "M.S.R." alloys have been introduced by J. Stone & Company (Charlton) Limited, members of the J. Stone (Holdings) Group. The potential usefulness of alloys of this type in both cast and wrought forms has been established, but the present announcement refers specially to compositions intended for casting. These alloys—there are two variants, M.S.R. (A) and M.S.R. (B) — are distinguished by proof stress values at levels hitherto attainable only with aluminium-base alloys.

Mechanical properties of the alloy are developed by two-stage heat-treatment and as with other age-hardening systems a variety of combinations of proof stress and elongation is possible by adjustment of heat-treatment conditions or composition, or both. Proof stresses up to 13½ tons/in² are attainable with a low ductility, but castings are currently being offered in material conforming to two tentative specifications of which the following are the typical properties:

	A	B
0·1 per cent proof stress Tons/in²—not less than	10	11
Ultimate tensile stress Tons/in²—not less than	15	15
Elongation, per cent—not less than	4	2

The "M.S.R." alloys have a density of 1·82 gm/cm³. They exhibit a good resistance to creep at temperatures of the order of 200°C., and a knowledge of their metallurgical make-up suggests that they should perform well in tensile or short-term creep tests at elevated temperatures. The suitability of the alloys to engine and other castings subject to long term heating, or to missile components where short-term heating applies, is apparent. The alloys have good casting qualities and are fully weldable. They are not liable to stress-corrosion failure. The "M.S.R." alloys contain zirconium and fall within the broad coverage of certain alloy and process patents owned by Magnesium Elektron Ltd., under which J. Stone & Co. (Charlton) are licensed.

Finishing Supplement

Plating Die-Castings

Based on work carried out by Dr. Henry Brown of the Udylite Research Corporation of America, this article discusses the protection offered by plated coatings on zinc die-castings and the mechanism of the corrosive attack. It has been abstracted from "Precision Metal Molding." In this country, Udylite are associated with Electro-Chemical Engineering Co. Ltd.

A VERY substantial improvement in the outdoor performance of chrome plated zinc die-castings (as well as steel)[1] can be obtained by using about 0·03 mil final chromium plate on the present thicknesses of copper and nickel plate instead of the usual 0·01 mil thickness of final chromium plate. It is important, however, to deposit the final, thicker chromium plate of 0·03 mil or more from warmer baths[1,2] and higher ratios of chromic acid to sulphate than is usually used.

In the past it was thought that the function of the final chromium plate was to keep the underlying nickel plate from tarnishing. The thickness of the underlying copper and nickel plate (especially the nickel plate) was entirely responsible for the corrosion protection.

This was quite true for polished dull-nickel plate on which most corrosion studies were made. This is quite untrue for fine-grained bright-nickel plate, which is now almost universally used. With bright-nickel plate, both the thickness of the nickel plate and the porosity and thickness of the final chromium plate are important.

It is the porosity of the final thin chromium plate that is a key factor in the premature corrosion failure of nickel-chromium and copper-nickel-chromium plate, whether applied on die-cast zinc or steel.

Actually, the premature failures occur mainly in exposure in industrial atmospheres. containing traces of sulphurous and sulphuric acid, soot and fly-ash from the burning of coal.

The exhaust gases of automobiles contribute other acids to the industrial atmosphere. The presence of these acids in the atmosphere, and their attendant concentration in the heavy dew condensation of the late autumn, winter and early spring, causes the premature corrosion of chrome-plated metal on automobiles that are not washed often and are left outdoors during the cooler part of the seasons.

The corrosive atmosphere is now further aggravated by the increased acidity of the exhaust gases from automobiles using modern petrols, and from the tremendous amounts of salt used to de-ice the streets in winter.

Neutral wet salt is not very harmful, as the salt-spray test shows, but it is the wet salt plus acid that sets up the conditions for a severe galvanic cell.

Under such conditions, the surface of the chromium plate becomes the cathode and the underlying metal (usually nickel) exposed in the pores or stress-cracks of the bright chromium plate becomes the tiny anodes of the corrosion cell. The large cathodic areas and the very small anodic areas are exactly the conditions that favour rapid corrosion pitting of the underlying metal covered by the thin porous chromium plate.

Fig. 1 illustrates this corrosion cell. It is obvious that the thicker the underlying nickel plate, or the more resistant the nickel can be made to anodic attack, the better the corrosion protection to the base metal.

Since the corrosion pit bores laterally as well as down, increasing thickness of nickel plate past about 0·5 mil gives geometrically improved corrosion resistance. A 1·5 mil thick nickel plate gives much more than twice the protection a 0·75 mil thick plate would give, assuming the same chromium plate was applied.

In general, the least objectionable corrosion pit is the type that tends to widen at the top at a faster rate (at least about double or more) than the rate of penetration downwards towards the basis metal. Also, the distribution density of the pores in the chromium plate is a very important factor. A very great many small pores very close together may be less harmful than a medium dispersion of pores in the chromium plate. Here, the cathodic area and the anodic areas (pores) would be more nearly equal, and the rate of corrosion pitting penetration would be less.

Of course, the absence of pores in the chromium plate would be the optimum condition. Certain stress-crack patterns in the chromium plate are often really less harmful than pores because the anodic area is not concentrated to a point attack as in a pore.

The results of a study of the porosity and stress-cracking of bright chromium plate of thicknesses of about 0·03 mil to 0·08 mil showed that the bright chromium plate obtained at bath temperatures of around 130°F., and with ratios of chromic acid to sulphate of 120:1 to 175:1, had minimum porosity and stress-cracks.

The main drawback in the use of higher bath temperature is not the loss of brightness of the chromium plate, but the necessity of using about twice the current density (250-325 amp/ft^2) compared to the operation at the usual bath temperatures of 100°F. to 115°F.

In automatic machines, or in hoist-line operations, the use of low voltage (2 to 3 V) on the entry of the work into the 130°F. chromium bath before the full plating voltage (or rather current density) is applied, makes possible better chromium coverage (especially in the high ratio chromic acid to sulphate baths which tend to give "rainbows" if this procedure is not followed).

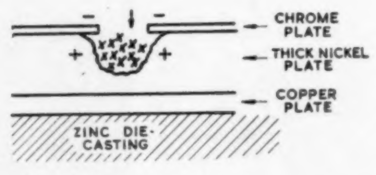
This is good practice for all chromium plating. Also at these bath temperatures and high ratios of chromic acid to sulphate, the 32 oz/gal. chromic acid bath has the best throwing power.[3]

There has often been a tendency in the automobile industry to regard the outdoor performance of chrome plated zinc die-castings as inferior to that of zinc plated steel.

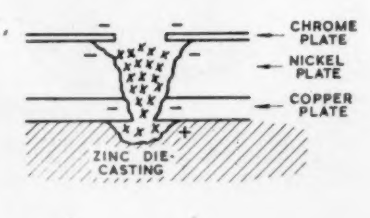
Since the specifications for the thickness of nickel plate underneath the chromium usually call for thicker nickel plate for steel parts than for zinc die-castings, it is hardly accurate to make such generalizations. Furthermore, due to the amazingly good casting properties of the zinc-base alloys, die-castings of very complex and intricate shape are common.

For these excessively intricate castings, it is quite difficult to plate the deeply recessed areas with specification plate. This fact, besides the generally lower specifications for plate thickness on zinc die-castings, is another factor that may have led to the erroneous generalizations favouring chrome-plated steel over chrome-plated zinc die-castings.

Actually, if steel could be formed in as intricate shapes as zinc die-castings, and plated to the same specification as that normally applied to zinc die-



Diagrams depicting progress of corrosive attack through pinhole failure



castings, it would fail worse in outdoor exposure.

However, there is no question that the use of the 130°F. chromium bath, preferably at ratios of about 125:1 to 175:1 of chromic acid anhydride to sulphate, or any other type of bright chromium plating bath that has minimum porosity and stress, and plating about 0·03 mil to 0·08 mil thickness of chromium plate, will result in great improvement in outdoor corrosion resistance of chrome-plated die-cast zinc.

Other methods of improving the outdoor corrosion resistance of copper-nickel-chromium plated zinc die-castings are being studied, and some are already in use, such as using a dual nickel plate instead of just bright nickel plate. The dual nickel plate consists of about 70 per cent to 80 per cent semi-bright sulphur-free nickel, followed by thinner bright nickel plate to brighten up the semi-bright nickel to full lustre. This type of composite nickel plate gives good results in Corrodkote and copper-chloride-acetic acid modified salt spray.[4]

The Corrodkote test consists of applying a coating of kaolin mixed with ammonium chloride, ferric chloride and copper nitrate, on the chrome plated article and then placing the article in a humidity cabinet, kept at 98 per cent humidity, for 20 hr.

Besides the Corrodkote, the acetic acid modified salt-spray, a very important and one of the earliest acidic type salt-spray tests, has now been made more corrosive, to shorten the testing time, by the addition of cupric chloride and raising the temperature (to 122°F.) of the spray of acetic acid plus salt and cupric chloride. This test is usually run from 8 hr. to 30 hr., and is also a very severe accelerated corrosion test. It is indicative of the performance of a chrome plated part on an automobile during one-year exposure in the most severe outdoor industrial atmosphere.

In any case, the use of the thicker bright chromium plate of minimum porosity and stress improves the corrosion resistance of any system of nickel-chromium or copper-nickel-chromium plating of zinc die-castings. By using at least 4½ min. chromium plating time, and preferably 6 min. or 7 min. to obtain 0·03 mil, or even a little thicker chromium plate of minimum porosity and stress cracks, a great improvement in the outdoor corrosion resistance of copper-nickel-chromium plate on zinc die-castings will result.

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1 H. Brown, M. Weinberg and R. J. Clauss; *Plating*, Feb., 1958.

2 E. J. Seyb, A. A. Johnson and A. C. Tulumello; *Proc. Amer. Electroplaters' Soc.*, 1957, **44**, 29.

3 W. Blum and H. L. Farber; *Res. Paper No.* 131, *J. Research Nat'l Bur. Standards*, 1930, **4**, 27.

4 W. L. Pinner; *Plating*, 1957, **44**, 763.

Remote Control of Level

REPLACING the "Proxicon" Mark II, a new capacitance type industrial level controller which is designed to control the levels of any liquids or free-flowing solids without necessitating direct contact with the material, and which has no moving parts in the container, has been introduced by J. Edward Hall (Elec. Engineers) Limited, Clarence Road Works, Leeds, 10. This instrument, the Proxicon Mark III, incorporates a number of improvements, including the following:

The addition of tapped electrode terminals, whereby remote control can be extended up to 3,000 ft. using V.R.I., M.I.C.C., and other standard types of cable.

The incorporation of heavy-duty contactor type double-pole changeover relay with "Elkonite" faced contacts, in place of the Post Office type, giving greatly improved contact life and increased flexibility in control circuit functions.

The provision of a "trigger" circuit by which "snap" operation is ensured even with a slow capacitance change, due to slow movement of material levels.

The addition of a separate signal station unit, which incorporates the mains voltage signal lamps, formerly included in the main control unit, has eliminated the overheating problem and gives the advantage of unrestricted siting for easy visibility.

Improved circuitry and manufacturing techniques set a new standard in enabling sensitivities greater than 1·0 pf to be achieved under all conditions subject to variations of not more than ±0·25 pf with mains variations of +5 per cent to −7½ per cent, and not more than ±1 pf with temperature variation of ±20°F. from a 68°F. datum figure.

Independent enclosure of relays, which are front of panel mounted for easy contact inspection.

The resilient mounting of valves and "plant alive" indicator lamps.

The inclusion of H.R.C.-type cartridge fuses for relay circuits.

The fitting of post type terminals with shell clamps for mains, relay and electrode wiring.

The provision of an electrode switch for simple selection of high or low level operations, with a "fail to safe" feature in either condition of working.

The set point is situated in a very accessible position and can be easily adjusted on site.

Quick and easy removal of chassis, giving greatly improved servicing facilities.

This instrument can be supplied for single and dual level applications, voltage ranges 100/125, 200/250 and 360/450 V, cycle range 40/60. Three voltage tappings are incorporated for each range to enable exact site voltage to be selected.

It can be custom built to special order for multiple level applications for up to 24 high and low level control points in any combination. Electrodes are available to meet all applications.

The "Proxicon" industrial remote level controller for single level applications.

Reviews of the Month

NEW BOOKS AND THEIR AUTHORS

POWDER METALLURGY

"Tooling for Metal Powder Parts." *By George H. De Groat. Published by McGraw-Hill Publishing Co. Ltd., 95 Farringdon Street, London, E.C.4. Pp. 242+xi. Price 58s. 0d.*

THIS book, produced under the direction of The National Technical Publications Committee of the American Society of Tool Engineers, who consulted an impressive list of metallurgists and engineers well known in the powder metal field, is a most valuable addition to the books on powder metallurgy, and the first to attempt to gather the available data on tooling and planning into a connected whole. With such authorities behind the preparation of the volume, the claim that the data are "professionally accurate and technically useful" is fully justified.

The first chapter is particularly valuable to the engineer with only a small knowledge of the potentialities of powder metallurgy, for not only are the advantages and limitations dealt with in comprehensive fashion, but there is included a "Process Case Study Comparison" for a small component in which the costs of production of the part by (a) turning, (b) press operations, and (c) powder metal are calculated in great detail for each process, and showing, in this instance, a most convincing saving by the powder method. This chapter is followed by a well illustrated one on the design of structural parts for production in metal powders.

The next chapter follows the basic process for the production of structural parts, in logical sequence, commencing with a short survey of the principal methods of producing powders, commenting on the characteristics of the powders produced by each method, and including several tables detailing the properties of various types of powder; the testing and preparation of powders for use are also given attention. These aspects of the technique are dealt with in a relatively simple fashion, such that the engineer with little acquaintance with the chemistry and metallurgy involved in the process will have no difficulty in following. The chapter on sintering techniques is on similar lines, and deals with atmospheres as well as furnaces, including information and comments on the importance of furnace control.

The sections devoted to briquetting tools and presses contain a number of dimensional line drawings which will be of great interest to engineers with the responsibility of producing tools for particular jobs, but the question of selection of tool materials is treated almost as an incidental, and although the foreword states that "metallurgical data have been kept to a minimum," and refers the reader to the materials suppliers, an unbiased appraisal would, in the opinion of the reviewer, be an advantage, for tool life and maintenance of dimensional accuracy are so considerably dependent on the tool material and its treatment.

The finai chapter covers finishing operations, including coining, machining, plating and heat-treatment, here, again, with numbers of illustrations and line drawings of tools and operational set-ups.

A glossary of terms and a bibliography of publications, mainly from the 1953-55 period, completes a most attractive volume. The type is clear and easily read and, with one or two exceptions, the illustrations are well reproduced. The binding is an attractive blue, but the covers are rather flexible and the wisdom of this is debatable for a book containing so much valuable information that it is likely to find a permanent place on the tool designer's desk.

For any production engineer anxious to become acquainted with what the field of powder metallurgy has to offer, it would be difficult to find a better introduction to the subject, whilst for the tool designer it will prove invaluable. **J. F. C. M.**

ROLLING MILL PRACTICE

"The Calculation of Load and Torque in Hot Flat Rolling." *By P. M. Cook and A. W. McCrum. Published by The British Iron and Steel Research Association, 11 Park Lane, London, W.1. Price 65s. 0d.*

OF interest to all engineers, designers, and others concerned with the hot rolling of steel, this book provides a concentration of essential data not previously available. Before load and torque can be calculated, the resistance of steel to deformation must first be known for the speed and temperature in question—information which cannot be calculated from formulae but which must be determined experimentally.

The book contains, in essence, the results of five years' work at B.I.S.R.A.'s Sheffield laboratories in determining stress-strain curves for steel in compression at temperatures up to 1,200°C., and over a range of deformation speeds usually met in working practice.

It describes the method and contains the data for calculating the load and torque for twelve steels. The ninety-six large graphs give the necessary "mean yield strength" data for these steels at 900, 1,000, 1,100 and 1,200°C., over a range of strain rates and reductions covering all industrial requirements. Other graphs are provided from which the strain-rate and geometrical functions associated with any particular operation can rapidly be calculated.

The preface explains Sims's formulae for load and torque, and gives examples of calculations from the data contained in the graphs.

In order to give full value to the graphs, the format of the book is unusually large—12½ in. by 13 in.—and it is robustly produced to stand up to use in works and rolling mills. There is a special plastics binding to allow further sheets to be inserted.

WELDED STRUCTURES

"The Calculations of Deformations of Welded Structures." *By N. O. Okerblom. Originally published by Mashgiz, Moscow, 1955. Translation published by Her Majesty's Stationery Office, 1958. Pp. 234. Price 15s.*

THERE is, indeed, hardly a branch of the engineering industries which is not engaged in the attempt to adopt, in some way or other, welding operations. The science and art of welding—for it is, most assuredly, both a science and an art, is, therefore, most naturally developing techniques which, while particularly its own, have been borrowed and adapted from the older and more established branches of technology. Many of the problems involved in welding fabrications are not always easily understood; however, by reference to such work as that of this translation, many of the problems arising from thermal effects, such as warping, deformation, and residual stresses, may become more clearly elucidated.

The translation has been prepared by the Department of Scientific and Industrial Research in the hope that it will be of significant practical interest in the important field of the growing welding industry.

The work, originally intended for Russian engineers and designers in the welding industry, has been revised and brought reasonably well up to date by V. D. Matskevich, a Russian specialist in welding technology. The reader may analyse various welding deformations and theoretically determine the complicated stresses that occur in welded structures, and such may, by reference to this book, be estimated without much effort and reasonably quickly, thereby reducing fabricating difficulties. Furthermore, some clear indications may be obtained whereby excessive distortion and residual stresses may be reduced, if not avoided. Results obtained from investigations made at the Leningradski Korablestroitel'nom Institute, Bridge Construction Research Institute, Shipbuilding Research Institute, Welding

Industry's Research Institute, etc., are utilized in order to describe the methods to offset warping and deformations in weldments.

Thermal heterogeneity resulting from welding processes is discussed, and numerous illustrations of warping and distortion, with possible stress concentrations and residual stresses, are given. Many good examples of heat flow in metal are given, with numerous formulae for understanding the heat flow in steel sheet and plate of differing thicknesses. The effects of single pass welds in contrast to multi-pass welds are analysed, and compared with continuous welds and discontinuous welds, and both longitudinal welds and fillet welds are described.

The effect of clamping, jigging and pre-setting to offset local deformations, and how to counter angular warping and distortion, receive adequate attention.

This book may be recommended to all engineers and designers connected with welded metal structures.

D. Ll.

NUCLEAR FUELS

"Uranium and Thorium." *By L. Grainger, B.Sc., A.I.M. Published by George Newnes Ltd., Tower House, Southampton Street, Strand, London, W.C.2. Pp.* 204+*vi. Price* 25*s.*

BRITAIN is engaged in exploiting the production of electricity from the release of nuclear energy. Reactors under construction by various industrial groups are to a well-tried formula (natural uranium fuel, graphite moderated and gas cooled) developed through successive stages—GLEEP, BEPO, Windscale and Calder Hall.

When the power output of operating and projected reactors is graphed against the year of commissioning, the curve rises with increasing steepness, power output more than doubling in each two-year period. This is a quite remarkable achievement, and although there may be limitations to further direct advances, other attractive variations are possible.

Higher output from nuclear power stations has two important effects: first, increased efficiency, which means that electricity from the atom may be cheaper than electricity from coal in as little as four years from now; and, secondly, the scientific and engineering effort available will be able to provide a far larger electrical output than was anticipated. In these circumstances, there is an incentive for conversion from fossil fuels to the more economic nuclear fuels—uranium and thorium. Cheap power can be the mainspring of important industrial and scientific advances.

Electrical energy and process heat are widely used, and many professions require some knowledge of fuel technology. A book aimed at explaining the metallurgy of the nuclear fuels is, therefore, particularly welcome. Mr. Grainger is chief metallurgist in the Industrial Group of the Atomic Energy Authority, and formerly was head of laboratories at Springfields, where much of the development of fuel elements for Windscale, Calder Hall and Dounreay was carried out. He is, therefore, in a particularly favourable position to survey the field. This he has done in a reasonably comprehensive manner, following the logical pattern—ores, extraction, properties, principal uses, with an interposed chapter on health hazards. The book is intended for engineers and others associated with, but not necessarily engaged in, the nuclear power industry. No attempt has been made to be exhaustive and references are, in the main, limited to review articles. The book more than fulfils the aims set out in the introduction. The observations which follow are made in the hope that later editions will be more generally useful.

Since metallic fuels will be in use for some years, more space could, with advantage, be devoted to the intriguing behaviour of fuels undergoing irradiation in a nuclear reactor. Overcoming the defects so produced has been of considerable importance in the devising of satisfactory fuel elements. For the sake of completeness, a chapter could be added on the third nuclear fuel, plutonium, which is recovered as a by-product from uranium fuelled reactors. A surprising omission in the chapter on health hazards is the lack of reference to "criticality" control in manufacturing processes. This is an important requirement, particularly when concentrated fissile isotopes are handled: readers could have been informed of the principles and how they are applied.

Minor criticisms are: more line diagrams could be introduced into the text, and that on p. 105 requires annotation and is incomplete; flow charts now in block form would be more memorable if illustrative of the processes.

Acknowledgment is made of the large amount of information released at the first Geneva Conference on Atomic Energy. A second conference is now in preparation, and we may expect that the author will be able to incorporate the new material in later editions of his book. It is to be expected that more sophisticated fuel elements will be required, and these will involve extension of fabricating techniques. In this connection, Table 24—Summary of Important Fuel Elements—might list them in chronological order, from which some indications of trends might be sought.

The book can be confidently recommended to those for whom it is written, and to engineers and metallurgists entering the atomic energy field, as an authoritative and readable review in a style both simple and direct. The price is reasonable and within reach of students requiring a textbook on the metallurgy of nuclear fuels.

W. F. B.

RADIATION EFFECTS

"The Effects of Radiation on Materials." *Edited by J. J. Harwood, H. H. Hausner, J. G. Morse and W. G. Rauch. Published by Reinhold Publishing Corporation, New York.* 1958. *Pp.* 355+*iv. Price* 84*s.* 0*d.*

THE twelve review articles assembled in this book were originally contributed to an educational colloquium held at John Hopkins University, U.S.A. The general theoretical and experimental background is authoritatively presented by G. J. Dienes, but his material has been rendered very familiar by other similar reviews. The chapter by J. C. Wilson on how to do irradiation experiments is much more original, and presents an excellent account of practical experience of such operations in the U.S.A. It should be read by anyone contemplating research in this field. D. S. Billington indicates the general pattern of the effects of radiations on metals and alloys, but his contribution is loosely written and the critical reader will often wish to turn to the fuller treatments to which reference is made. The only merit of C. E. Weber's Paper on the effects of radiation on the core components of nuclear reactors is that some hitherto classified work is presented; the general treatment is very untidy. The subject of moderators and shielding is dealt with by G. R. Hennig. The final article of direct metallurgical interest is by M. Simnad, and deals with the unusual corrosion effects that can occur in the presence of radiation. The remainder of the book is concerned with the results of subjecting ionic crystals, semi-conductors and organic substances (including polymers) to various radiations.

This book can only be recommended to those who want to have a general survey of uneven quality between two covers. It is a pity that the concerted efforts of four editors could not have imposed some uniformity of style in the presentation of diagrams: some have useful captions extending over half a page; others have curious captions or none. The book is well bound and printed on good quality paper.

T. B.

Nitrate Determination

A FURTHER monograph in the series "Organic Chemical Reagents" has been issued by Hopkin and Williams Ltd., Chadwell Heath, Essex. This describes the methods used for the estimation of nitrate ion by means of the reagent 2:4-Xylenol. Two methods, distillation and extraction, are described, and the effects of interference by chloride and nitrite are discussed.

Industrial News *Home and Overseas*

New Telephone Number

It is announced by Deutsch and Brenner Ltd. that the telephone number of their Manchester branch office has been changed to Manchester Gatley 6418.

Selling to Holland

Sales manager of the industrial instruments division of **Firth Cleveland Instruments Ltd.**, Mr. S. F. Smith is visiting agents in Amsterdam to further the sales of British-made equipment in Holland. He is accompanied by Mr. D. T. Broadbent, an executive director and chief engineer of the company.

Firth Cleveland Instruments Ltd. is a subsidiary of Simmonds Aerocessories Ltd. and a member of the Firth Cleveland group.

German Trade Fair

Non-ferrous metals will be very much in evidence in Berlin on September 13 next when the German Industries Exhibition opens there, to continue until September 28. The exhibition, at which British firms will also be showing, will have exhibits from both Eastern and Western Germany. Other countries showing non-ferrous metal products will include Canada, France and the United States.

African Aluminium Scheme

A project in which firms from four countries wlll participate, and which will lead to what is described as the largest aluminium processing plant in the world, has recently been announced by the American Olin Mathieson Chemical Corporation. It is proposed to exploit the bauxite deposits in French West Africa. The United States firm is reported to have a participation of 53½ per cent in the project, two French firms a total of 26½ per cent, and a British and a Swiss concern 10 per cent each.

The area concerned is in the territory of French Guinea, where work on the plant is reported to have already commenced. Present estimates are that about 1,500 million tons of mineable bauxite are available in the area. A railway line is to be laid from the plant to the seaport of Conakry, and a town for more than 4,000 workers and their families is planned near the plant site.

Aluminium Hatch Covers

In recent years there has been an increasing interest in the possibilities of aluminium as a material for hatch covers, and the announcement that complete sets of welded aluminium MacGregor insulated 'tween deck covers are to be fitted in three Royal Mail Line ships, now being built at Belfast by Harland and Wolff Ltd., comes as a result of much development work and of successful service experience with existing installations. The structural design of these covers has been developed by MacGregor and Company Ltd. in conjunction with Saunders-Roe (Anglesey) Ltd., who are fabricating them from material supplied by **Northern Aluminium Company Ltd**.

Mechanically operated hatch covers have become standard equipment in many types of ship, and there is no doubt that the MacGregor cover, originally patented by MacGregor and Company (Naval Architects) Ltd., of Whitley Bay, Northumberland, and now fitted in over 2,700 ships throughout the world, is the best known and most popular of the several designs available.

In hatch covers the weight saving made possible by the use of aluminium can have a dual advantage, for it both increases the cargo deadweight of the ship and at the same time facilitates handling. The corrosion resistance of the material and a consequent reduction in maintenance can also be taken into account, and all these factors together can more than outweigh the increased first cost of aluminium covers.

Protective Clothing

An exceptionally comprehensive range of protective clothing for both factory and outdoor workers is now being marketed by the newly-formed protective clothing division of **Scaffolding (Great Britain) Ltd.** Included in the products they offer are boiler suits, overalls, gloves, aprons, safety footwear, helmets and goggles, whilst more particularly for the outdoor worker there are rubber boots, donkey jackets, waterproof clothing and duffle coats. A special feature of the company's service is that distribution of all these products is made from stocks held at the company's 36 branches throughout the country.

News from Russia

According to statistics published recently by the Ministry of Foreign Trade, Soviet exports in 1957 included the following (in 1,000 metric tons): manganese ore 917·8, chrome ore 219·0, and zinc concentrates 33·1.

At present the only minerals being exploited in Transbaikalia (Siberia beyond Lake Baikal) are non-ferrous ores, according to the Industrial and Economic Gazette. However, a major deposit of molybdenum near Sirigichensk, discovered five years ago, still remains untapped.

Geologists have found deposits of the scarcer metals, including titanium-bearing magnetite, in the region of Chita. But exploitation is hampered by the lack of concentration plant and smelters, and by inadequate electricity supplies. Originally it was planned to build major ore processing plants in this area in the period from 1959-1961. However, electrification of the area is to be speeded up and it is hoped that plans can be advanced.

About Vitreosil

An interesting and useful handbook of some 48 pages has just been issued by **The Thermal Syndicate Ltd.** This book is not a catalogue or price list and it is, we are told, the only reference book on fused quartz and silica in the world. The title of the book—"About Vitreosil"—has been specially chosen because the book is an explanation of the material, what it is, how it is worked, present applications and purposes for which it may be used.

In addition to the general information, there are also two appendices which give the chemical behaviour of Vitreosil and its applications. The information contained in this book is as comprehensive as possible, and copies may be obtained on application to the company.

A New Division

The formation of a Gas Atmospheres Division has been announced by the **Incandescent Heat Company Ltd.** This division, headed by Mr. I. L. S. Golding, will co-ordinate the Incandescent group's activities in this field, and will be responsible for the design, development and sales promotion of gas and controlled atmosphere generators and gas dryers.

Backed by the company's long experience with this type of plant, the new division will intensify the company's effort in this important branch of metallurgy and chemical engineering.

Overseas Exhibitions

We are advised by **Alexander Cardew Limited** that their principals—A. Triulzi, s.a.s., are participating in the Milan Machine Tool Exhibition, which is being held next month. Two large stands have been taken by the company, which will have on display hot and cold chamber die-casting machines (both water hydraulic and oil operated), arbor presses, double acting presses, compression moulding presses, punching presses, as well as machines of special interest, such as a bending press, and possibly a press for producing records.

The Italian firm will also participate in the International Technical Exhibition which is to take place in Turin from late September until October 7 next.

A Luncheon Meeting

On Wednesday, September 3 next, the first luncheon meeting of the winter session of **The Non-Ferrous Club** will be held at the Queen's Hotel, Birmingham, at 12.15 p.m. The guest speaker on this occasion will be Mr. R. G. W. Plutte, who is managing director of London Zinc Mills Ltd., and also a director of Enfield Rolling Mills Ltd.

A Visit to Rugby

As part of their annual outing, some forty members of the North Staffordshire branch of the Association of Mining, Electrical and Mechanical Engineers, with their President, Mr. T. I. Paterson, visited the Rugby works of the **British Thomson-Houston Co. Ltd.** last week as guests of the A.E.I. heavy plant division.

The visitors were welcomed on arrival by Mr. H. E. Cox, a director of the company and general manager of the Rugby works. After light refreshments, the visitors were able to tour the fabrication, heavy plant, generator and gear factories. During this period the ladies who accompanied the members were able to visit Rugby School.

A Birmingham Exhibit

At the Symposium on Microchemistry, organized by the Midlands Section and Microchemistry Group of the Society for Analytical Chemistry, being held at Birmingham University, opening on Wednesday last and continuing until next Wednesday (August 27), **Baird and**

Tatlock (London) Ltd. are showing a selection from their new range of equipment for chromatography and electrophoresis, including the fraction collector, the electrophoretic horizontal tank, the electrophoretic constant current/constant voltage unit (high stability model), the electrophoretic densitometer and chromatographic tanks for strip, multi-sheet and two-dimensional paper chromatography. Other B.T.L. exhibits wll include the "Analmatic" dispensing pipette unit, the zone-melting apparatus (N.C.L. pattern), the new silent shaker, the wide range oven with fan, the sedimentation apparatus (I.C.I. pattern), the rapid micro-combustion unit for carbon and hydrogen, the rapid micro-combustion unit for halogens and sulphur, the micro electrolytic analysis apparatus, and a selection of stirrers and microchemical glassware.

Industrial Training

A residential course for industrial training officers is to be held from the evening of Sunday, September 7, until the afternoon of Friday, September 12, at the Prince of Wales Hotel, London, W.8. Sponsored jointly by the Industrial Welfare Society, the Institute of Personnel Management, and the British Association for Commercial and Industrial Education, the course is designed to help the training officer who has some experience in industry.

In addition to formal lectures, delegates will explore special interests in study groups, working through case studies of selected aspects of training in companies represented on the course. Enquiries about this course should be directed to the courses secretary, Institute of Personnel Management, 80 Fetter Lane, London, E.C.4.

A Sales Conference

At a meeting which was attended recently by the directors and all the salesmen, engineers and chemists of **Silvercrown Limited,** details of the company's new products and processes were given. These include the completely re-designed range of high performance plating barrels and filters, as well as centrifugal dryers and resistance boards.

The supersonic range of fast and bright plating solutions for copper, nickel, zinc, cadmium and silver was also discussed, and a film was shown featuring some of the latest automatic and manual plating plants installed by the company in actual operation. The photograph on this page shows the group meeting at the head office of the company in London.

Copper Find in Canada

Reports from Toronto state that Kennecott Copper Corporation's Canadian exploration subsidiary has made a copper discovery in Quebec in the Mattagami Lake-Bell River region. Several shallow drill holes in a group of claims east of Bell River have uncovered copper and zinc mineralization similar to the New Hosco find 12 miles to the west. Drilling started two weeks ago on property held by Kennco Explorations, Canada, with a single drill in operation.

Aluminium Industry for Ghana

News from Accra is to the effect that Aluminium Union Limited, of Canada is planning to install a £100,000 aluminium fabricating industry in Ghana. This was stated by Mr. J. A. Peterson, who is holding talks with the Ghana Government officials as resident representative of the company. Initially, the company is to manufacture aluminium building materials and sheets from aluminium imported from Canada, and is later planning to manufacture household utensils.

Aluminium in Queensland

Establishment of an aluminium industry on Cape York Peninsula in Northern Queensland would need a capital of A£200 million or more for a smelter with an annual capacity of some 250,000 tons, according to Mr. D. S. Hibberd, director of the Commonwealth Aluminium Corporation Pty. Ltd. He added that additional export revenue accruing as a result of the establishment of such a plant would amount to some £60 million annually. Mr. Hibberd added that the exact capital cost of the plant would depend on the associated power plant chosen.

Some time ago, the company said it had taken an option on the Blair Athol coal deposits with a view to studying the possibility of exploiting them for a thermal power station. It is understood that first results are very encouraging and that the coal seam, under some 30 ft. of overburden, is about 100 ft. thick. Open-cast mining methods would be used to provide a medium-grade fuel at very low cost. Earlier, the company was studying the possibility of using a nuclear power station as its source of electricity for the processing plant. The plant would have developed about 30,000 kW. However, in view of the promise of Blair Athol, it seems highly unlikely that the company will be in the nuclear market.

Sales conference at London headquarters of Silvercrown Limited

British Timken Meeting

Next week will see the opening by Sir John Pascoe, chairman of **British Timken Ltd.,** of an important overseas sales conference which will be attended by over 100 sales and technical representatives of the company. The conference will be held at the Leofric Hotel, Coventry, and during the event members of the conference will be paying visits to the company's factories at Daventry and Duston, and to the subsidiary—Fischer Bearings Company at Wolverhampton—as well as the Birmingham Railway Carriage and Wagon Company, and the Standard Motor Company.

The object of the conference is to examine the foreign markets that exist for British made tapered roller bearings and to ascertain how the company can contribute still more to this important part of the British export drive.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week totalled 17,045 tons, comprising London 6,127, Liverpool 9,453, and Hull 1,465 tons. Copper stocks totalled 12,342 tons, and comprised London 6,249, Liverpool 5,818, Birmingham 75, Manchester 50 and Swansea 150 tons.

Polish Copper Find

East German press reports say that in the Breslau area, a deposit of copper ore estimated to contain 10,000,000 tons of the metal has been discovered. The vein is said to cover an area of about 200 square kilometres, and in certain sections the copper minerals are reported to contain as much as 10 per cent of the metal. The reports say that it is believed that exploitation will begin next year.

Exhibits at Farnborough

Apart from the usual attractive flying display which will be made at the annual meeting of the Society of British Aircraft Constructors at Farnborough, from September 1 to 7 next, there will also be the trade exhibition, which will invite special attention.

Among the many exhibitors will be the following:—**Albright and Wilson (Mfg.) Ltd.** will be showing on Stand 199 components displaying the advantages of Kanigen, the chemical nickel-phosphorus plating process now being operated in this country by the company. Other items shown will include some guided missile components, including a fly-off body used in the "Thunderbird" ground-to-air

guided weapon; also several types of aircraft valves, such as the aluminium and ni-resist valves used in hot air systems for cabin heating, de-icing, etc., in many different types of aircraft.

The two chief exhibits on the stand (No. 134) of **Northern Aluminium Company Ltd.** are, first, part of an aircraft structural member, 9 ft. by 2 ft. 6 in. by $1\frac{1}{2}$ in., machined from a piece of aluminium plate; exemplifying the use of integral construction which is being increasingly adopted in aircraft design, it also illustrates the facilities that the company now offer in producing large stress-free plate for this purpose. The other main exhibit is a hand forging in Noral B75S (D.T.D.683A), 5 ft. long and weighing three-quarters of a ton, several of which have been produced for a new aircraft of one of the leading manufacturers. Forging was carried out on a 4,000-ton press recently installed at the company's Birmingham works. Other Noral forgings are displayed, together with a selection of castings in Noral 226 alloy (B.S.1490:LM.11), and, in addition, the "Noralduct" roll-bonded heat exchanger plate, incorporating internal systems of ducts and cells.

On Stand 211, part of the display provided by **Westinghouse Brake and Signal Company Limited,** devoted to recent advances in the field of semi-conductors, will include selenium rectifiers for aircraft power supplies, high temperature lightweight selenium rectifiers for H.T. supplies and magnetic amplifier circuits, copper-oxide units for instrument and telecommunication applications, and the latest types of germanium and silicon diodes. Also exhibited will be large selenium and germanium rectifier equipments for aircraft and allied industries needing reliable sources of D.C. power for varying processes.

A wide range of specialized fire detecting and fire extinguishing equipment for aircraft will be displayed on Stand 60 by **The Pyrene Company Ltd.** This range will include airfield crash tenders, smoke detecting equipment, impact crash switch, duo-head CO_2 fire extinguishing system, etc., and there will also be illustrations of the application of "Pyrene" metal finishing processes used in the aircraft and guided missile industry, including "Parkerizing," "Bonderite S.S." and "Pyluminizing."

M.O.R. fluids for the non-destructive detection of flaws in aircraft components, including the "Britemor" fluorescent process, which is now A.I.D. approved, will be demonstrated on the stand of the **Manchester Oil Refinery Group of Companies.** Exhibited by **Flexibox Limited** will be a full range of mechanical seals for rotary shaft airborne mechanisms.

Titanium will be the principal product on display on the stand of the Metals Division of **Imperial Chemical Industries Limited,** and examples will be shown of the many uses of this metal in sheet or rod form, in practically every military aircraft in production (including the Vulcan and Victor, the P.1 and P.11, the Sea Vixen and the Scimitar), and in several airliners such as the Britannia and Comet. It is also used widely in aero engines. The Rolls-Royce Avon, Conway and Tyne, the Bristol Proteus and the de Havilland Gyron Junior all incorporate components fabricated in titanium. Among the most interesting exhibits will be a helicopter engine cowling, a blown flap duct assembly, compressor blades, titanium extrusions, and tubes for hydraulic systems. A two-ton titanium ingot—the largest yet made in Europe—melted in Metals Division's new furnaces at Witton, Birmingham, will provide one of the most spectacular exhibits. "Kynal" aluminium roll-welded heat transfer sheet and copper or aluminium "Tube-in-Strip," both of which provide passageways integral with the sheet, will be featured on another section of the stand, together with "Integron" integral-finned tubing.

Marston Excelsior Limited—a subsidiary company of I.C.I.—will exhibit the new "Portolite" flexible tank for the transport and storage of aircraft fuels. "Portolite" tanks are made from a sandwich material comprising two layers of a very strong woven fabric with an interlayer of a rubber-like material. They have been designed to provide simple, lightweight containers for the transport and storage of liquids. Other new developments to be seen on Marston Excelsior's stand will include aircraft heat exchangers in both titanium and stainless steel, and flash butt welded titanium rings. The "Marlite" and "Flexelite" flexible fuel tanks will also be on show.

Men and Metals

Joining Murex Welding Processes Limited as leader of the Fundamental Section of the Research Department, **Dr. M. F. Jordan** succeeds **Dr. W. D. Biggs,** who has now left the company to take up an appointment in the Engineering Department of Cambridge University. Dr. Jordan graduated in 1951 with an honours degree in Industrial Metallurgy at Birmingham University, and subsequently became a member of the "Joining of Metals" research team at that university. Before joining Murex, Dr. Jordan was on the staff of Aluminium Laboratories Limited, at Banbury, for two and a half years, and worked in the casting section of the company's metallurgy division.

Also joining the Fundamental Research team of the Murex concern is **Mr. H. J. Wellard,** B.Sc. He obtained his degree at Bristol University in 1945, and while there undertook research on the phase transitions in barium titanate. In 1949 Mr. Wellard joined the British Rayon Research Association in Manchester, and up to the time of his present appointment was engaged on investigations by X-ray crystallography of the structures of fibre-forming polymers.

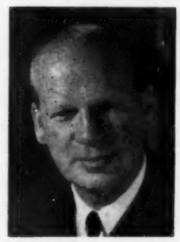
Wilmot Breeden Fellowships for 1958 have been awarded to **Dr. V. S. K. Nair,** M.Sc., of the University of Glasgow, and **Mr. P. J. Whybrow,** B.Sc., of the Royal Aircraft Establishment. They will be held in association with the College of Technology, Birmingham, for two years from next month (September).

With a long and distinguished record with British Insulated Callender's Cables Limited over a period of 32 years, **Mr. Q. W. Minshull,** B.Sc., M.I.E.E., has been appointed general manager of the company's power cables division. Mr. Minshull was educated at Tettenhall College, Wolverhampton, and at Birmingham University.

Following the recent resignation of **Mr. F. R. Livock,** the director, it has been announced by the British Institute of Management that **Mr. D. Macdougald** has been appointed general secretary of the institute.

Engineering contracts manager for Chamberlain Industries Ltd., **Mr. E. G. Kimsey,** A.M.I.C.E., A.M.I.Mech.E., is to visit the United States and Canada during next September and October to discuss the application of the "Staffa" slow speed, high torque, hydraulic motor which the company is now manufacturing.

It has been announced by Venesta Limited that **Mr. Stanley Field** has been appointed chairman of the company in succession to **Mr. Henry Rutherford,** who recently relinquished that position on medical advice and was created the company's first Honorary President. From 1948 to 1953, Mr. Field was senior partner of W. N. Middleton and Company, at the



same time acting as financial and general adviser to a number of industrial concerns. In 1953 he became managing director of the Prestige Group Limited, and shortly afterwards a director of the parent company, Ekco Products, of Chicago. Two years later Mr. Field became a director of Venesta, and in February of this present year he relinquished his directorships of Prestige and Ekco to become deputy chairman of Venesta.

An announcement from Toronto is to the effect that **Mr. William M. Frames,** of Johannesburg, formerly chairman of Rand Mines Limited, has been named chairman of The International Nickel Company S.A. (Proprietary) Limited, South African subsidiary of The International Nickel Company of Canada Limited. Mr. Frames will continue as a director of Rand Mines Limited, with which he has been associated for 37 years, and as a director of other companies. In his new appointment Mr. Frames will be chief executive officer of the South African subsidiary of Inco, which is engaged in mineral exploration and investment.

Metal Market News

THE most interesting news last week was the announcement on Friday that, with the exception of nickel, the non-ferrous metals had been put on the free list so far as Iron Curtain countries were concerned. The effect on copper, as might have been expected, was a firmer market, but the rise was hardly as great as some people expected, and on the day the improvement in value was no more than about 30s. It is, of course, too early to say what the result of this freeing of exports is going to mean, but on the whole the feeling is that more copper will go into consumption. It seems likely the Iron Curtain countries are hungry for copper, and there may well be some good business coming to the U.K., for America will not apparently publish a list of permitted exports for some time yet. The standard copper market was fairly active, with a turnover last week of more than 8,000 tons including Kerb business. On balance, cash advanced by 30s. and three months by 15s., the quotation being £208 10s. 0d. for both positions. That the contango should have disappeared is a matter for regret, and it is much to be hoped that a backwardation will not develop in the near future. Warehouse stocks are now very much lower than they were, but last week brought no further reduction, the total remaining at 12,457 tons. The background of trading in copper continued to be favourable last week, although Wall Street showed some spasms of weakness. Share values on the London Stock Exchange were helped by the reduction in the Bank Rate to 4½ per cent. Nevertheless, there are some signs that in this country a slowing down may be in progress, which may gain momentum as the autumn approaches. Too late to influence the trend of values last week, for it was after the afternoon market was over, cabled news from America announced that the outlook for clearing the Minerals Stabilization Bill this session was much brighter. Earlier in the week it appeared as though the chances of getting the necessary approval of the House before the vacation were not at all good.

Stocks of tin in L.M.E. warehouses dropped by 216 tons to 17,532 tons but, nevertheless, the tone of the market was rather weak and the three months' position dropped by £6 10s. 0d. to £728 while cash lost £1 to close at £730 10s. 0d. The turnover was about 1,560 tons. A fair amount of support buying at £730 was in evidence. Consumers are not showing much interest and, according to the Bureau of Non-Ferrous Metal Statistics, usage of tin in the U.K. during the first half of this year was only 9,893 tons, against 11,739 tons in 1957. The reduction in the U.S. lead price to 10·75 cents caused weakness on the London market which, on a turnover of 3,875 tons, lost £2 for August and 27s. 6d. November, closing at £70 5s. 0d. and £71 15s. 0d. About 5,350 tons of zinc changed hands, the close being £64 August and £65 November, these prices showing losses of 15s. and 7s. 6d. for the respective positions.

Figures issued by the Copper Institute, in short tons of 2,000 lb., for July are as follows: inside the United States production of crude copper was 73,120, against 82,072, while the output of refined was 110,130, compared with 107,918. Deliveries of refined copper were, as anticipated, sharply lower, the total of 77,523 tons comparing with 100,796 tons in June. Stocks were about 2,700 tons down at 242,781 tons. Outside the United States, production of crude copper was 152,784, against 143,775, while output of refined was less than 1,000 tons down at 119,559 tons. Deliveries were more than 3,000 tons up at 143,278 tons. There was an increase of about 1,100 tons in stocks of refined copper at 232,494 tons. Electrolytic copper is still scarce in Europe, and the premium on wirebars is anything from £12 to £14 per ton.

Birmingham

Activity in the Midland industrial towns is lower than it has been for a very long time. The tendency of reducing stocks in preference to placing new orders seems likely to continue for a while. Unemployment is increasing and there are fewer vacancies, even for skilled and semi-skilled operatives. Makers of stampings and pressings providing components for the motor trade maintain a good rate of production, but apart from that there has not yet been revival elsewhere. If hire purchase becomes easier because of the lowering of the Bank Rate, an increase in sales of domestic and household appliances can be expected. Active conditions continue amongst makers of electrical plant for equipment of power stations in this country and abroad.

Deliveries of steel to coal mining and railways dropped sharply in the second quarter compared with the corresponding period last year. This was offset to some extent by the increase in material accepted by the motor industry and the electrical engineering trade. The decline in output of iron and steel continues, and more workers have been put on short time. Foundries making heavy castings for the engineering industries continue well employed, but a good deal of short time is reported from the light foundries. There are abundant supplies of iron and steel scrap, and merchants are hoping to export some of the surplus now that restrictions on shipments have been lifted.

New York

The feature of the U.S. non-ferrous metal market in the past week was a short-lived rising trend in copper prices. This was halted by custom smelters who, at mid-week, cut their price by one-half a cent per lb. to 26½ cents. This action cancelled a half-cent rise to 27 cents made by custom smelter firms about five days before. The cut, according to trade reports, reflected light sales custom smelters had experienced at the 27 cent level. At the 26.50 cent level the smelters reported fair sales.

Large producers reported that the demand for copper at their 26.50 cent price was "fairly good," although not as active as a few weeks ago. Some industry sources estimate producers' July shipments of refined copper to consumer plants at around 80,000 tons. The estimated July deliveries would compare with June shipments of 100,296 tons, which had been swollen by price rise fears. In May, copper shipments were 78,631 tons.

Scrap copper prices dropped from 21.75 cents to 21.25 cents per lb. in the week. The reduction in the selling price of electrolytic by custom smelters was an influence.

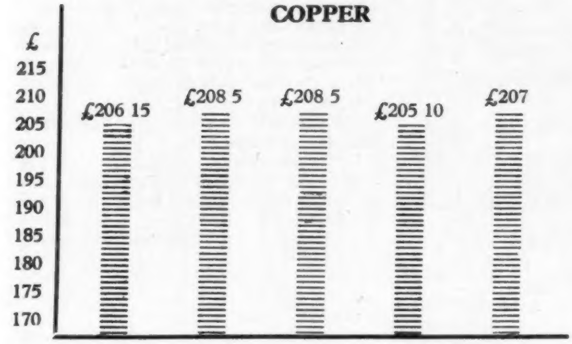
The situation in lead was described as unchanged. Consumers have been taking moderate tonnages for shipment this month. The zinc trade was heartened by the July statistics in that they confirmed what had been hoped for, namely, that the industry was putting its house in order. It was admitted that further corrective measures were needed to bring about a better balance beween supply and demand.

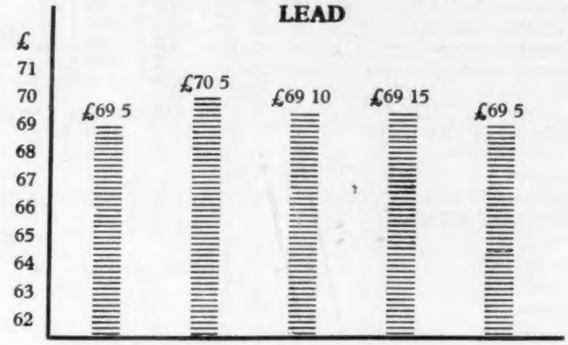
Washington observers believe that chances are poor for getting the Minerals Subsidy Bill through Congress with the necessary financing provided for in the remaining few days of this session. However, they do not rule out the possibility completely. The Bill's importance to the copper industry stems from the provision that calls for the Government to stockpile purchases over a one-year period of up to 150,000 tons of U.S. copper at prices up to 27½ cents a lb. For lead and zinc, the Bill calls for a five-year price subsidy payment of not more than 3·9 cents a lb. for lead and 2·9 cents a lb. for zinc below maximum fixed price ceilings. It also sets maximum annual tonnages which are considerably above present U.S. mine production schedules of both metals.

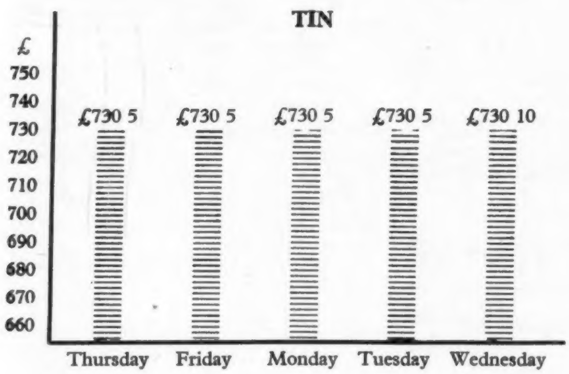
During the past week, tin market business was described as quiet and prices eased slightly.

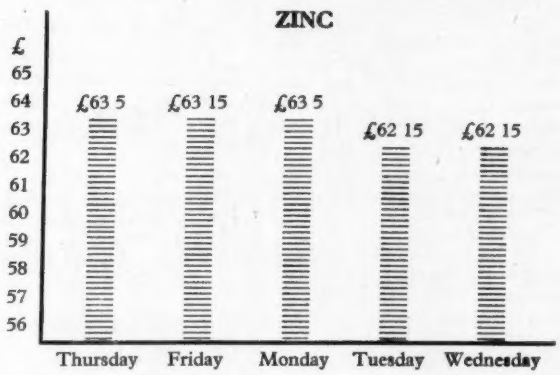
METAL PRICE CHANGES

LONDON METAL EXCHANGE, Thursday 14 August 1958 to Wednesday 20 August 1958









OVERSEAS PRICES

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg ≏ £/ton		Canada c/lb ≏ £/ton		France fr/kg ≏ £/ton		Italy lire/kg ≏ £/ton		Switzerland fr/kg ≏ £/ton		United States c/lb ≏ £/ton	
Aluminium			22.50	185 17 6	210	182 15	375	217 10			26.80	214 10
Antimony 99.0					195	169 12 6	420	243 12 6			29.00	232 0
Cadmium					1,500	1,305 0					155.00	1,240 0
Copper												
Crude												
Wire bars 99.9							415	240 15				
Electrolytic	29.00	212 0	24.75	204 10	260	226 5			2.45	192 12 6	26.50	212 0
Lead			10.50	86 15	110	95 15	179	103 17 6	.87	77 15	10.75	86 0
Magnesium												
Nickel			70.00	578 5	1,205	1,048 7 6	1,300	754 0	7.80	652 5	74.00	592 0
Tin	101.25	740 2 6			892	776 0	1,400	812 0	8.60	719 2 6	94.12	753 0
Zinc												
Prime western			10.00	82 12 6							10.00	80 0
High grade 99.95			10.60	87 10 0								
High grade 99.99			11.00	90 5								
Thermic					107.12	93 2 6						
Electrolytic					115.12	100 2 6	159	92 5	.82	68 10	11.25	90 0

NON-FERROUS METAL PRICES

(All prices quoted are those available at 12 noon 20/8/58)

PRIMARY METALS

		£	s.	d.
Aluminium Ingots....	ton	180	0	0
Antimony 99·6%	„	197	0	0
Antimony Metal 99%..	„	190	0	0
Antimony Oxide......	„	180	0	0
Antimony Sulphide Lump..............	„	190	0	0
Antimony Sulphide Black Powder........	„	205	0	0
Arsenic..............	„	400	0	0
Bismuth 99·95%......	lb.		16	0
Cadmium 99·9%	„		10	0
Calcium	„	2	0	0
Cerium 99%	„	16	0	0
Chromium	„		6	11
Cobalt	„		16	0
Columbite.... per unit			—	
Copper H.C. Electro..	ton	206	5	0
Fire Refined 99·70%	„	205	0	0
Fire Refined 99·50%	„	204	0	0
Copper Sulphate	„	70	0	0
Germanium	grm.		—	
Gold	oz.	12	10	0¾
Indium	„		10	0
Iridium	„	20	0	0
Lanthanum	grm.		15	0
Lead English..........	ton	69	5	0
Magnesium Ingots....	lb.		2	5½
Notched Bar	„		2	10½
Powder Grade 4	„		6	3
Alloy Ingot, A8 or AZ91	„		2	8
Manganese Metal	ton	290	0	0
Mercury	flask	79	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.		nom.	
Osmiridium	„		nom.	
Palladium	„	5	15	0
Platinum	„	23	5	0
Rhodium	„	40	0	0
Ruthenium	„	16	0	0
Selenium	lb.		nom.	
Silicon 98%	ton		nom.	
Silver Spot Bars	oz.		6	3
Tellurium	lb.		15	0
Tin	ton	730	10	0
***Zinc**				
Electrolytic..........	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	63	0	0
Dust 95/97%..........	„	104	0	0
Dust 98/99%..........	„	110	0	0
Granulated 99+% ..	„	88	0	0
Granulated 99·99+%	„	100	12	6

***Duty and Carriage to customers' works for buyers' account.**

INGOT METALS

Aluminium Alloy (Virgin)		£	s.	d.
B.S. 1490 L.M.5	ton	210	0	0
B.S. 1490 L.M.6	„	202	0	0
B.S. 1490 L.M.7	„	216	0	0
B.S. 1490 L.M.8	„	203	0	0
B.S. 1490 L.M.9	„	203	0	0
B.S. 1490 L.M.10....	„	221	0	0
B.S. 1490 L.M.11....	„	215	0	0
B.S. 1490 L.M.12....	„	223	0	0
B.S. 1490 L.M.13....	„	216	0	0
B.S. 1490 L.M.14....	„	224	0	0
B.S. 1490 L.M.15....	„	210	0	0
B.S. 1490 L.M.16....	„	206	0	0
B.S. 1490 L.M.18....	„	203	0	0
B.S. 1490 L.M.22....	„	210	0	0

		£	s.	d.
†Aluminium Alloy (Secondary)				
B.S. 1490 L.M.1	ton	145	10	0
B.S. 1490 L.M.2	„	155	10	0
B.S. 1490 L.M.4	„	173	10	0
B.S. 1490 L.M.6	„	190	0	0

†Average selling prices for mid July

		£	s.	d.
***Aluminium Bronze**				
BSS 1400 AB.1......	ton	213	0	0
BSS 1400 AB.2......	„	215	0	0
***Brass**				
BSS 1400-B3 65/35 ..	„	140	0	0
BSS 249	„		—	
BSS 1400-B6 85/15 ..	„		—	
***Gunmetal**				
R.C.H. 3/4% ton....	ton		—	
(85/5/5/5)	„	170	0	0
(86/7/5/2)	„	181	0	0
(88/10/2/1)	„	233	0	0
(88/10/2/½)	„	242	0	0
Manganese Bronze				
BSS 1400 HTB1....	„	173	0	0
BSS 1400 HTB2....	„	191	0	0
BSS 1400 HTB3....	„		—	
Nickel Silver				
Casting Quality 12%	„		nom.	
„ „ 16%	„		nom.	
„ „ 18%	„		nom.	
***Phosphor Bronze**				
2B8 guaranteed A.I.D. released	„	255	0	0
Phosphor Copper				
10%	„	230	0	0
15%	„	237	0	0

Average prices for the last week-end.

		£	s.	d.
Phosphor Tin				
5%	ton		—	
Silicon Bronze				
BSS 1400-SB1	„		—	
Solder, soft, BSS 219				
Grade C Tinmans....	„	347	6	0
Grade D Plumbers..	„	281	6	0
Grade M	„	380	6	0
Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.		—	
Type 9 „	„		—	
Zinc Alloys				
Mazak III	ton	93	17	6
Mazak V	„	97	17	6
Kayem	„	103	17	6
Kayem II	„	109	17	6
Sodium-Zinc........	lb.		2	5

SEMI-FABRICATED PRODUCTS

Prices of all semi-fabricated products vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium		£	s.	d.
Sheet 10 S.W.G.	lb.		2	8
Sheet 18 S.W.G.	„		2	10
Sheet 24 S.W.G.	„		3	1
Strip 10 S.W.G.	„		2	8
Strip 18 S.W.G.	„		2	9
Strip 24 S.W.G.	„		2	10½
Circles 22 S.W.G.	„		3	2
Circles 18 S.W.G.	„		3	1
Circles 12 S.W.G.	„		3	0
Plate as rolled	„		2	7½
Sections	„		3	1½
Wire 10 S.W.G........	„		2	11
Tubes 1 in. o.d. 16 S.W.G.	„		4	0

		£	s.	d.
Aluminium Alloys				
BS1470. HS10W.	lb.			
Sheet 10 S.W.G.	„		3	0½
Sheet 18 S.W.G.	„		3	3
Sheet 24 S.W.G.	„		3	10½
Strip 10 S.W.G.	„		3	0½
Strip 18 S.W.G.	„		3	2
Strip 24 S.W.G.	„		3	10
BS1477 HP30M.				
Plate as rolled	„		2	10½
BS1470. HC15WP.				
Sheet 10 S.W.G.	lb.		3	6½
Sheet 18 S.W.G.	„		4	0½
Sheet 24 S.W.G.	„		4	10½
Strip 10 S.W.G.	„		3	9½
Strip 18 S.W.G.	„		4	0½
Strip 24 S.W.G.	„		4	8
BS1477. HPC15WP.				
Plate heat treated ..	„		3	5½
BS1475. HG10W.				
Wire 10 S.W.G.	„		3	9½
BS1471. HT10WP.				
Tubes 1 in. o.d. 16 S.W.G.	„		4	11
BS1476. HE10WP.				
Sections	„		3	1
Beryllium Copper				
Strip	„	1	4	11
Rod	„	1	1	6
Wire	„	1	4	9
Brass Tubes..........	„		1	7¾
Brazed Tubes........	„		—	
Drawn Strip Sections	„		—	
Sheet	ton		—	
Strip	„	229	10	0
Extruded Bar........	lb.		1	9⅞
Extruded Bar (Pure Metal Basis)	„		—	
Condenser Plate (Yellow Metal)	ton	166	0	0
Condenser Plate (Naval Brass)	„	177	0	0
Wire	lb.		2	5
Copper Tubes	lb.		2	0¼
Sheet	ton	235	15	0
Strip	„	235	15	0
Plain Plates	„		—	
Locomotive Rods	„		—	
H.C. Wire	„	257	15	0
Cupro Nickel				
Tubes 70/30	lb.		3	4¾
Lead Pipes (London) ..	ton	110	0	0
Sheets (London)	„	107	15	0
Tellurium Lead	„	£6 extra		
Nickel Silver				
Sheet and Strip 7% ..	„		3	5¼
Wire 10%	„		3	11¾
Phosphor Bronze				
Wire	„		3	9¾

Titanium (1,000 lb. lots)			
Billet over 4" dia.-18" dia.	lb.	63/-	64/-
Rod 4" dia. - ·250" dia. ..	„	75/-	112/-
Wire under ·250" diam. - ·036" diam.	„	146/-	222/-
Sheet 8'×2'×·250"-·010" thick	„	88/-	157/-
Strip ·048"-·003" thick..	„	100/-	350/-
Tube (representative gauge)	„		300/-
Extrusions	„		120/-

		£	s.	d.
Zinc Sheets, English destinations	ton	97	0	0
Strip	„		nom.	

Financial News

Metal Statistics

Detailed figures of the consumption and output of non-ferrous metals for the month of June, 1958, have been issued by the British Bureau of Non-Ferrous Metal Statistics, as follow in long tons:—

COPPER	Gross Weight	Copper Content
Wire	27,478	27,171
Rods, bars and sections	11,531	7,710
Sheet, strips and plate	12,177	9,751
Tubes	7,514	6,961
Castings and miscellaneous	6,456	—
Sulphate	2,120	—
	67,276	57,418

Of which:

Consumption of Virgin Copper	46,080
Consumption of Copper and Alloy Scrap (Copper Content)	11,338

ZINC	
Galvanizing	7,411
Brass	7,625
Rolled Zinc	2,235
Zinc Oxide	2,051
Zinc Die-casting alloy	4,447
Zinc Dust	916
Miscellaneous Uses	902
Total, All Trades	25,587

Of which:

High purity 99·99 per cent	4,762
Electrolytic and high grade 99·95 per cent	4,941
Prime Western, G.O.B. and debased	9,122
Remelted	347
Scrap Brass and other Cu alloys	3,420
Scrap Zinc, alloys and residues	2,766

ANTIMONY	
Batteries	131
Other Antimonial Lead	84
Bearings	32
Oxides—for White Pigments	114
Oxides—other	71
Miscellaneous Uses	14
Sulphides	4
Total Consumption	450

Antimony in Scrap	
For Antimonial Lead	355
For Other Uses	30
Total Consumption	385

LEAD	
Cables	8,420
Batteries	2,464
Battery Oxides	2,318
Tetra Ethyl Lead	1,481
Other Oxides and Compounds	2,133
White Lead	862
Shot	398
Sheet and Pipe	5,767
Foil and Collapsible Tubes	361
Other Rolled and Extruded	493
Solder	1,156
Alloys	1,762
Miscellaneous Uses	1,009
Total	28,624

CADMIUM	
Plating Anodes	40·60
Plating Salts	8·15
Alloys: Cadmium Copper	4·45
Alloys: Other	2·35
Batteries: Alkaline	5·25
Batteries: Dry	0·45
Solder	3·25
Colours	18·55
Miscellaneous Uses	1·60
Total Consumption	84·65

TIN	
Tinplate	850
Tinning:	
Copper Wire	40
Steel Wire	9
All other	62
Solder	165
Alloys	451
Foil and Collapsible Tubes, etc.	45
Tin Compounds and Salts	88
Miscellaneous Uses	9
Total Consumption	1,719

Sutcliffe, Speakman

In his annual report, the chairman of the company, Mr. M. H. Stothert, states that sales in the current year are running at a satisfactory level. Orders on hand for solvent recovery plant are substantial and the position in the non-ferrous department has improved, although this market is still difficult and highly competitive. Group net assets are higher at £416,970, against £388,984. Group net profits of £44,814 compare with £43,227, and the dividend remains at 12½ per cent.

Engineering Components

Group profits for the first half of this year, to June 30, before taxation are shown at £190,000, against £201,000 for the same period of 1957. Group sales over the period have shown an increase in value of just over 11 per cent.

Thompson Bros. (Bilston)

It is reported that John Thompson, the Midlands business of combustion and general engineers, is making a bid for the issued share capital of Thompson Bros. (Bilston), which carries on a similar type of business. For each £1 6 per cent tax-free Preference share a cash price of 35s. is to be offered, while the bid for the Ordinary capital is on the basis of an exchange of shares, one John Thompson 5s. Ordinary stock unit being offered for every two 5s. units of Thompson Bros.

Scrap Metal Prices

Merchants' average buying prices delivered, per ton, 19/8/58.

	£
Aluminium	
New Cuttings	134
Old Rolled	110
Segregated Turnings	90
Brass	
Cuttings	128
Rod Ends	125
Heavy Yellow	108
Light	103
Rolled	120
Collected Scrap	104
Turnings	118
Copper	
Wire	176
Firebox, cut up	168
Heavy	166
Light	161
Cuttings	176
Turnings	158
Braziery	138
Gunmetal	
Gear Wheels	166
Admiralty	166
Commercial	141
Turnings	136
Lead	
Scrap	61
Nickel	
Cuttings	—
Anodes	450
Phosphor Bronze	
Scrap	141
Turnings	136
Zinc	
Remelted	55
Cuttings	42
Old Zinc	30

The latest available scrap prices quoted on foreign markets are as follow. (The figures in brackets give the English equivalents in £1 per ton):—

West Germany (D-marks per 100 kilos):

Used copper wire	(£178.7.6)	205
Heavy copper	(£174.0.0)	200
Light copper	(£148.0.0)	170
Heavy brass	(£108.15.0)	125
Light brass	(£82.12.6)	95
Soft lead scrap	(£61.0.0)	70
Zinc scrap	(£34.17.6)	40
Used aluminium unsorted	(£87.0.0)	100

France (francs per kilo):

Copper	(£208.17.6)	240
Heavy copper	(£208.17.6)	240
Light brass	(£143.10.0)	165
Zinc castings	(£65.5.0)	75
Lead	(£82.12.6)	95
Tin	(£565.10.0)	650
Aluminium	(£117.10.0)	135

Italy (lire per kilo):

Aluminium soft sheet clippings (new)	(£191.10.0)	330
Aluminium copper alloy	(£116.0.0)	200
Lead, soft, first quality	(£84.12.6)	146
Lead, battery plates	(£49.17.6)	86
Copper, first grade	(£194.7.6)	335
Copper, second grade	(£179.17.6)	310
Bronze, first quality machinery	(£188.10.0)	325
Bronze, commercial gunmetal	(£159.10.0)	275
Brass, heavy	(£130.10.0)	225
Brass, light	(£119.0.0)	205
Brass, bar turnings	(£127.12.6)	220
New zinc sheet clippings	(£55.2.6)	95
Old zinc	(£40.12.6)	70

THE STOCK EXCHANGE

Turnover Heavier And Prices Showed All Round Advance

ISSUED CAPITAL ●	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 19 AUGUST	+RISE —FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1958 HIGH	1958 LOW	1957 HIGH	1957 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	21/3		9	10	8 11 6	21/3	17/6	28/3	18/–
400,000	2/–	Anti-Attrition Metal	1/6		4	8½	5 6 9	1/6	1/3	2/6	1/6
33,639,483	Stk. (£1)	Associated Electrical Industries ...	53/3	+1/–	15	15	5 12 9	53/3	46/6	72/3	47/9
1,590,000	1	Birfield Industries	52/6		15	15	5 14 3	57/–	46/3	70/–	48/9
3,196,667	1	Birmid Industries	73/–	+2/–	17½	17½	4 16 0	71/6	55/3	80/6	55/9
5,630,344	Stk. (£1)	Birmingham Small Arms	32/1½	+2/1½	10	8	6 4 6	32/1½	23/9	33/–	21/9
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	15/4½		5	5	6 10 0	15/7½	14/7½	16/–	15/–
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/3		6	6	6 19 3	17/3	16/6	19/–	16/6
500,000	1	Bolton (Thos.) & Sons	24/4½		12½	12½	10 5 3	28/9	24/–	30/3	28/9
300,000	1	Ditto Pref. 5%	15/–		5	5	6 13 3	16/–	15/–	16/9	14/3
160,000	1	Booth (James) & Co. Cum. Pref. 7%	20/–		7	7	7 0 0	19/4½	19/–	22/3	18/9
9,000,000	Stk. (£1)	British Aluminium Co.	52/–	+1/3	12	12	4 12 3	52/–	36/6	72/–	38/3
1,500,000	Stk. (£1)	Ditto Pref. 6%	18/10½		6	6	6 7 3	19/3	18/4½	21/6	18/–
15,000,000	Stk. (£1)	British Insulated Callender's Cables	45/3	+2/3	12½	12½	5 10 6	45/6	38/9	55/–	40/–
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	39/6	+1/–	10	10	5 1 3	39/6	29/–	39/–	29/6
600,000	Stk. (5/–)	Canning (W.) & Co.	20/–		25+ *2½C	25	6 5 0	21/–	19/7½	24/6	19/3
60,484	1/–	Carr (Chas.)	1/6	+1½d.	25	25	11 13 3X	2/3	1/4½	3/6	2/1½
150,000	2/–	Case (Alfred) & Co. Ltd.	4/1½	+1½d.	25	25	12 2 6	4/9	4/–	4/6	4/–
555,000	1	Clifford (Chas.) Ltd.	19/–		10	10	10 10 6	19/–	16/–	20/6	15/9
45,000	1	Ditto Cum. Pref. 6%	15/9		6	6	7 12 6	15/10½	15/7½	17/6	16/–
250,000	2/–	Coley Metals	2/9		20	25	14 11 0	4/6	2/6	5/7½	3/9
8,730,596	1	Cons. Zinc Corp.†	49/6		18¾	22½	7 11 6	51/6	41/–	92/6	49/–
1,136,233	1	Davy & United	70/6	+6/9	20	15	5 13 6	70/6	45/9	60/6	42/6
2,750,000	5/–	Delta Metal	21/3	+1/4½	30	*17½	7 1 3	21/4½	17/7½	28/6	19/–
4,160,000	Stk. (£1)	Enfield Rolling Mills Ltd.	33/–		12½	15B	7 11 6	34/–	22/9	38/6	25/–
750,000	1	Evered & Co.	27/9		15Z	15	7 4 0	28/3	26/–	52/9	42/–
18,000,000	Stk. (£1)	General Electric Co.	34/9	—6d.	10	12½	5 14 6	38/7½	29/6	59/–	38/–
1,500,000	Stk. (10/–)	General Refractories Ltd.	34/–	+1/–	20	17½	5 17 9	34/7½	27/3	37/–	26/9
401,240	1	Gibbons (Dudley) Ltd.	61/–	—2/–	15	15	4 18 3	66/3	61/–	71/–	53/–
750,000	5/–	Glacier Metal Co. Ltd.	5/6		11½	11½	10 9 3	6/6	5/6	8/1½	5/10½
1,750,000	5/–	Glynwed Tubes	14/4½		20	20	6 19 3	14/4½	12/10½	18/–	12/6
5,421,049	10/–	Goodlass Wall & Lead Industries ...	25/–	+9d	13‖	18Z	5 4 0	25/–	19/3	37/3	28/9
342,195	1	Greenwood & Batley	48/3		20	17½	8 5 9	49/3	45/–	50/–	46/–
396,000	5/–	Harrison (B'ham) Ord.	13/10½	+7½d.	*15	*15	5 8 0	13/10½	11/6	16/9	12/4½
150,000	1	Ditto Cum. Pref. 7%	19/–		7	7	7 7 3	19/–	18/9	22/3	18/7½
1,075,167	5/–	Heenan Group	8/3	+6d.	10	20‡	6 1 3	8/3	6/9	10/4½	6/9
216,531,615	Stk. (£1)	Imperial Chemical Industries ...	33/6	+1/3	12Z	10	4 15 6	33/6	27/7½	46/6	36/3
33,708,769	Stk. (£1)	Ditto Cum. Pref. 5%	16/6		5	5	6 1 3	17/1½	16/–	18/6	15/6
14,584,025	**	International Nickel	151½	—3½	$3.75	$3.75	4 8 6	154¾	132¾	222	130
430,000	5/–	Jenks (E. P.), Ltd.	7/6		27½ϕ	27½	9 3 3	8/3	6/9	18/10½	15/1½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	16/3	—6d.	5	5	6 3 0	16/9	15/–	17/–	14/6
3,987,435	1	Ditto Ord.	39/6	+1/6	10	10	5 1 3	45/3	36/6	58/9	40/–
600,000	10/–	Keith, Blackman	20/–		17½	15	8 15 0	20/–	15/–	21/9	15/–
160,000	4/–	London Aluminium	4/3		10	10	9 8 3	4/4½	3/–	6/9	3/6
2,400,000	1	London Elec. Wire & Smith's Ord. ...	46/6	+6d.	12½	12½	5 7 6	46/6	39/9	54/6	41/–
400,000	1	Ditto Pref.	23/3		7½	7½	6 9 0	23/3	22/3	25/3	21/9
765,012	1	McKechnie Brothers Ord.	36/9	+2/6	15	15	8 3 3	36/9	32/–	48/9	37/6
1,530,024	1	Ditto A Ord.	35/–	+2/–	15	15	8 11 6	35/–	30/–	47/6	36/–
1,108,268	5/–	Manganese Bronze & Brass	11/–	+9d.	20	27½‡	9 1 9	11/–	8/9	21/10½	7/6
50,628	6/–	Ditto (7½% N.C. Pref.)	5/9		7½	7½	7 16 6	6/3	5/9	6/6	5/–
13,098,855	Stk. (£1)	Metal Box	53/6		11	11	4 2 3	54/3	41/9	59/–	40/3
415,760	Stk. (2/–)	Metal Traders	7/6		50	50	13 6 9	7/7½	6/3	8/–	6/3
160,000	1	Mint (The) Birmingham	20/–	—1½d.	10	10	10 0 0	22/9	19/–	25/–	21/6
80,000	5	Ditto Pref. 6%	79/6		6	6	7 11 0	83/6	79/6	90/6	83/6
3,705,670	Stk. (£1)	Morgan Crucible A	38/6		10	10	5 4 0	40/–	34/–	54/–	35/–
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/3		5½	5½	6 7 6	17/3	17/–	19/3	16/–
2,200,000	Stk. (£1)	Murex	47/9		17½	20	7 6 9	58/9	47/9	79/9	57/–
468,000	5/–	Ratcliffs (Great Bridge)	8/6		10	10	5 17 9	8/7½	6/10½	8/–	6/10½
234,960	10/–	Sanderson Bros. & Newbould ...	25/6		20	27½D	7 16 9	27/–	24/6	41/–	24/9
1,365,000	Stk. (5/–)	Serck	15/3	+4½d.	17½Z	15	3 16 6	15/3	11/–	18/10½	11/6
600,400	Stk. (£1)	Stone (J.) & Co. (Holdings)	62/9	+3/6	18	16	5 14 9	62/9	43/9	57/6	43/9
600,000	1	Ditto Cum. Pref. 6½%	23/6	—9d.	6½	6½	5 10 9	24/3	19/6	21/9	18/9
14,494,862	Stk. (£1)	Tube Investments Ord.	57/9	+1/9	15	15	5 3 9	57/9	48/4½	70/9	50/6
41,000,000	Stk. (£1)	Vickers	33/3	+3d.	10	10	6 0 3	33/3	28/9	46/–	29/–
750,000	Stk. (£1)	Ditto Pref. 5%	14/3	—6d.	5	5	7 0 3	15/6	14/3	18/–	14/–
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	21/9	+6d.	*5	*5	7 1 3A	23/–	21/3	24/9	20/7½
2,200,000	1	Ward (Thos. W.), Ord.	79/3	+1/3	20	15	5 1 0	79/3	70/9	83/–	64/–
2,666,034	Stk. (£1)	Westinghouse Brake	38/3	+3d.	10	18P	5 4 6	40/–	32/6	85/–	29/1½
225,000	2/–	Wolverhampton Die-Casting ...	7/10½	+6d.	25	40	6 7 0	8/–	7/1½	10/1½	7/–
591,000	5/–	Wolverhampton Metal	19/3	+1/–	27½	27½	7 2 9	18/3	14/9	22/3	14/9
78,465	2/6	Wright, Bindley & Gell	4/–	+4½d.	20	17½E	12 10 0	4/–	3/3	3/9	2/7½
124,140	1	Ditto Cum. Pref. 6%	11/6		6	6	10 8 9	11/6	11/3	12/6	11/3
150,000	1/–	Zinc Alloy Rust Proof	2/10½	—1½d.	27	40D	9 7 9	3/1½	2/7½	5/–	2/9

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting **Shares of no Par Value. ‡ and 100% Capitalized Issue. ●The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. Y Calculated on 11½% dividend. ‖Adjusted to allow for capitalization issue. E for 15 months. P and 100% capitalized issue, also "rights" issue of 2 new shares at 35/– per share for £3 stock held. D and 50% capitalized issue. Z and 50% capitalized issue. B equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue. ϕ And 100% capitalized issue. X Calculated on 17½%. C Paid out of Capital Profits.